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THE 15-INCH GRUBB EQUATORIAL OF THE NIZAMIAH OBSERVATORY, HYDERABAD.*

By T. P. BHASKARAN.

The principal equipment of the Nizamiah Observatory consists of two telescopes—a photovisual, 8 inches in aperture, by Cooke, and a visual of 15 inches aperture by Grubb; both of them are provided with fine equatorial mountings. The telescopes were purchased by the late Nawab Zuffur Jung Bahadur, a nobleman of Hyderabad, who possessed a considerable taste for astronomy. They were at first erected at his private residence near the city, but some time later, the full equipment was handed over to H. E. H. the Nizam's Government for the establishment of an astronomical Observatory. In 1908 the instruments were dismounted and removed to their present location at Begumpet, a suburb of Hyderabad, about four miles distant from the city. The work of re-erecting the instruments was commenced immediately, and as the Observatory had by that time definitely undertaken to complete a section of the "Carte du Ciel," the installation of the photographic telescope was taken in hand first. No opportunity for the erection of the larger telescope presented itself and the several parts were consequently stored in the Observatory workshop. A beginning was however made in 1912, and the masonry work for the house was completed early in 1914, but for various reasons the work did not proceed further. It was only recently that it was found possible to resume the work on the instrument and, the necessary funds having been provided by the Government, the remaining work was pushed on as rapidly as possible under my direction and the installation was completed in October 1922.

The building for the accommodation of the equatorial was designed by the late Mr. A. B. Chatwood, the first Director of the Observatory, and is a two-storied circular house (diameter 23½ ft.) surrounded by a verandah 9½ ft. wide. The circular wall is of granite blocks quarried in the neighbourhood; at the centre of the house is a substantial pier also built of blocks of the same material, carefully dressed. It is built on a good foundation of concrete, and is in the form of a truncated pyramid. Above the level of the ground floor, the pier is

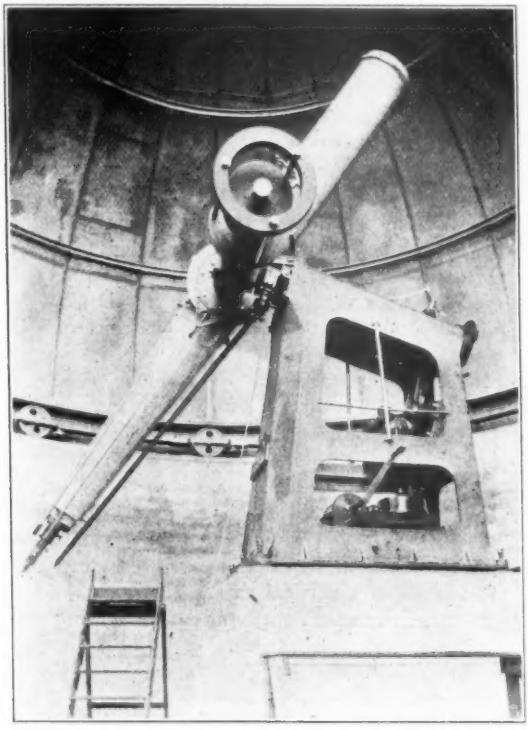
*Read before the Indian Science Congress, Lucknow meeting, Jan. 1923.

hollow, so as to allow the weights of the machinery for driving the telescope to descend vertically, and on its top is placed a single cap-stone for supporting the instrument. The upper floor is double planked, and forms the observing room. There is about half an inch clear space between the pier and the planking, so that the former is completely isolated from the floor. The observing room is approached by a wooden staircase in the outer verandah. The ground floor is used as a store room for miscellaneous articles.

THE NIZAMIAH OBSERVATORY, HYDERABAD.

The dome 25 ft. in diameter was constructed by Thomas Cooke & Sons, York, and is exactly similar to the dome of our Astrographic Equatorial. It is in the shape of a hemisphere and is covered with sheets of papier mâché. The frame work is of angle steel, and the vertical steel frames are riveted to a circular horizontal girder, on the inner side of which a toothed rack is cast. This girder is placed on wheels running on a circular planed cast iron rail. The structure is retained laterally in position by means of two sets of horizontal rollers; one set attached to the live ring is acting on the inside of the vertical flange of the cast iron rail while the other set, fixed to the bottom girder of the dome, is moving on the outer side of the flange. The rail was most carefully centred and levelled by a straight edge

before being bolted to the wall of the Observatory. A toothed wheel gears into the rack on the base girder and is connected by a vertical spindle and a pair of bevelled wheels, to the wheel which rotates the dome. The opening in the dome is carried a little beyond its topmost point so as to leave the view of objects near the zenith unobstructed. It is covered by a pair of shutters which slide laterally on rails attached to the girder. The shutters are opened by cords passing



THE 15-INCH TELESCOPE OF THE NIZAMIAH OBSERVATORY.

directly over pulleys and hanging alongside of the wall within convenient reach of the observer. Two catches are provided which firmly fasten the shutters after they are closed. The dome has been erected with the utmost care by the staff of the workshop attached to H. E. H. the Nizam's Mint Department. It turns with great ease and is very serviceable.

The equatorial mounting of the telescope is supported by the pier at the centre of the house. Two base plates are bolted to the capstone

on the top of the pier and the points of five strong screws passing through the flanges in the iron base (three on the North end and two on the South) rest on these plates. One of the screws on the North side bears in a countersink on the base plate and provides for the final adjustment for latitude. The other two screws are intended only for steadying the instrument and are just tightened down after the stand has been placed level on its base. On the South side, there is an arrangement fitted to the base plate for adjustments of the polar axis in azimuth by a pair of powerful screws acting in opposite directions on the stand of the instrument.

The southern side of the stand encloses all the apparatus connected with the driving of the telescope, such as the sector, the driving worm with its mounting, the clockwork, and also the gear for quick and slow motion in Right Ascension.

For the relief-friction of the polar axis the method devised by Repsold has been adopted; a friction roller is introduced which relieves the greater part of the pressure of the polar axis on its bearings. A screw is provided which, by means of levers, acts upon the friction wheel and regulates its upward thrust on the polar axis to a nicety. The arrangement works very well and the motion of the telescope both in R. A. and Decl. is very easy, considering the great weight of the moving parts.

The tube consists of three sections. The centre piece, which is bolted to the declination axis, is of cast iron with heavy ribs on both ends and the other two sections are fastened to the centre piece. The entire length of the tube is 15 ft. 6 inches. The centre of motion of the telescope is about 13 ft. above the floor of the observing room so that even objects near the zenith can be conveniently observed.

The driving clock is of Sir Howard Grubb's usual pattern and is controlled by a governor in which a heavy brass ring cut into eight sections is rotating about a vertical axis. This axis is connected by a train of wheels to a drum on which the cord carrying the weight is wound. No arrangement for automatic winding is introduced; it is simply wound by hand, when the weights reach the lowest position. The rate of driving is controlled by electric current sent to the circuit by a platinum point at the end of a seconds pendulum, which cuts through a globule of mercury at the middle point of its swing. The accelerating and retarding magnets act directly on the driving worm by means of a differential gear without affecting the rate of the governor. The slow motion in Right Ascension is given by means of a wheel introduced in the gear and worked by an endless cord in the observer's hand. A quick "Slow motion" is also provided by means of which the driving worm can be geared out of the train and turned by a handle so that the telescope moves in R. A. at a fairly rapid rate. The same contrivance, when the telescope is unclamped, serves for winding back the driving arc when it is "run out."

The telescope is throughout of good workmanship. It is hoped shortly to attach a position micrometer to the telescope for the measurement of double stars.

The object glass is a visual one and has a focal length of about 185 inches. In 1915, it was sent to Mr. Evershed, Director of the Kodaikanal Observatory, who requested the loan of this lens for some time and from his reports it appears to have done good work in connection with his study of spot-spectra, the Einstein shift of the spectral lines, and various other problems. The objective was returned in September 1922, when the mounting was ready for its reception. It is not well corrected for chromatic aberration, but otherwise seems to be a tolerably good lens. The various tests on its performance have not yet been completed. It is my purpose to apply the test by the method of extra-focal images to study its quality at an early opportunity. An account of these is reserved for a later communication.

Nizamiah Observatory, Hyderabad-Deccan, India, 1923. Jan.

THE METEORIC PROCESSION OF FEBRUARY 9, 1913.

By WILLIAM H. PICKERING.

PART IV.

We are now prepared to consider the location and orbit of the meteors prior to their capture by the earth. But first it is important to get the idea completely out of our minds that they came from a comet, or moved originally in a cometary orbit. Not, as we shall presently see, that such a thing is absolutely impossible, but rather that the probability of such an event is excessively small. Out of every 1000 meteors recorded, as based on the observations of Mr. Denning, about 30 will be as bright or brighter than the planet Jupiter, and would be called fireballs. Out of these 30, 4 will be found to move comparatively slowly,—noticeably more so than the others. A very minute proportion, on the average, of these 4 will reach the earth's surface, and be found, and will then be called stony meteorites. The remaining 996 move in cometary orbits with high velocities. Not one is likely to reach the surface of the earth, altho this has occasionally been known to occur. Those of them which have done so are found to be composed mainly of iron and nickel. The statistics indicate that 32 stony meteorites are seen to fall, to every one of these iron ones. Of the stony ones perhaps ten per cent contain iron in appreciable quantities, the remainder are composed mainly of silica, combined with magesium, aluminum, and calcium.

They are found to arrive in excess in May and June, but otherwise are pretty uniformly distributed throughout the year. The cometary meteors on the other hand arrive chiefly from July to November in-

clusive, when the orbits of Jupiter's comets approach most closely to that of the earth. The stony meteorites fall most frequently between 4 and 5 in the afternoon, while the cometary meteors are most abundant after midnight, about twelve hours later. This however is due to the fact that the stony meteorites are practically all moving in direct orbits, while the orbits of many of the iron meteors are retrograde.

The stony meteorites prior to their fall have been shown to move in orbits of average eccentricity 0.36, or less than that of the more eccentric asteroids, and less than that of any known comet. The eccentricity of the orbits of the iron meteorites on the other hand is about 0.56, and agrees in general with that of the comets of short period. Nearly half of the orbits of the stony meteorites lie within that of the earth, some of them extending to Venus, while some of the others at aphelion reach out as far as that of Mars. (POPULAR ASTRONOMY 1909, **17**, 273 and 1910, **18**, 262.)

There is therefore no reason to attempt to associate the Canadian meteors with any known meteoric or cometary radiant. It may be noted however that when they crossed the 105th meridian in Saskatchewan, in latitude 51°.63, they were coming from a point in practically the same right ascension as the sun, and 25°.5 to the north of it. Their azimuth at this time was S 73°.6 E. As we trace them backwards on their course all of these quantities change. As we trace them forward we find that they had already begun to move in a practically circular orbit.

With regard to their course prior to their encounter with the earth, there are two causes either of which may have brought on the final disaster. It is possible that before 1913 they were following an elliptical orbit around the sun, which closely coincided with that followed by the earth and moon. Had only one of these bodies, for instance the earth, existed, they would have been as safe from destruction as the moon itself, for size, or rather mass, under such circumstances is no protection from collision under the law of gravitation. But it may have so happened that in dodging from side to side of the earth, as the moon does today, they unfortunately got too near the moon, and the moon switched them off into a new orbit that brought them down on the earth.

Another thing that may have happened to them is that their orbit which in one place lay near to that of the earth, may have carried them off elsewhere out of reach of its protection. There they may have been disturbed by either Mars or Venus, or they may simply have come back to the earth again at the wrong time, and got too near it on their return. They very nearly escaped unharmed, for a couple of hundred miles farther from our planet would have kept them safe forever as tiny satellites.

It is in a way a curious circumstance that on April 5, 1913, just two months after the Canadian meteors appeared, Miss Grace Cook, the

well known English observer of meteors, was watching the skies in England, when she suddenly saw a group of about 15 or 20 meteors of the fifth magnitude, and looking very like the Pleiades, travelling slowly in a south-easterly direction,—the same direction as that taken by the Canadian group. They were visible for about 7 seconds, moved in an absolutely straight line, and finally closed up and disappeared in the distance. (Journ. B. A. A. 1913, **24**, 102.) On looking the matter up I find that in February 9, 14^h G. M. T., when the Canadian meteors appeared, the position of the moon was in $\alpha\ 0^h\,09^m$, $\delta\ +0°\ 53'$, while on April 5, $8^h.5$ when the English ones were seen, the moon was located in $\alpha\ 0^h\,20^m$, $\delta\ +2°\ 25'$. That is to say it was within 3° of its former position. While this result may be a mere coincidence, it would seem to favor the earlier explanation rather than the second one, and to indicate that in some way we owe the two phenomena indirectly to our moon.

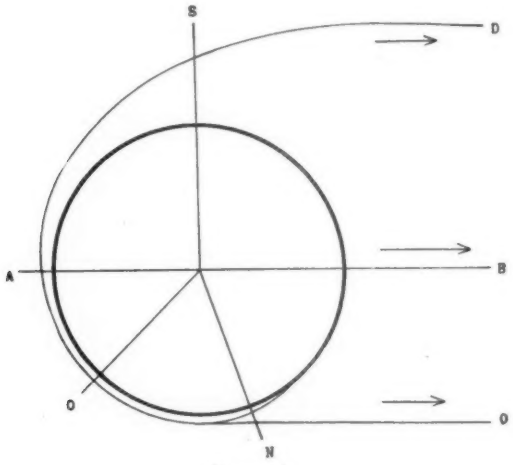


FIGURE 1.

In Figure 1 let the outer edge of the heavy circle indicate the surface of our earth, *A B* the line of its orbit, and *S* the direction of the sun. The lines to *O* and *N* indicate the locations of the Ontario and Newlands stations when the meteors appeared at those places. We will now consider in what manner we captured the meteors. It would not have been likely to have been done in those regions perpendicular or highly inclined to the earth's orbit, since it would have been extremely improbable that their transverse velocity and proximity to the earth would then have been exactly right for their capture. It must then have been near the top or the bottom of the figure. If at the bottom they were overtaking us, if at the top we were overtaking them.

The meteors themselves give us no clue to this question, but fortunately Professor Chant wisely included in his original paper a reference to several other bright meteors and fireballs, that were seen at about the same time as the great display. Some of the more interesting of these are as follows. At Brampton at 8:20 a bright meteor was seen moving quite slowly from north-west to south-east. This seems to have been a forerunner of the great display that was to follow 45 minutes later. At 9:30 a large ball of fire followed by several smaller balls were seen at Peterborough moving directly *westward*. It was also seen at Roblin and at Windsor. At 1:27 a brilliant meteor that lighted the whole heavens was seen travelling *westward* at Perm. It was visible for 12 seconds. It was also seen at Arthur, at Vittoria, and at Windsor. At Windsor about 2:20, 18 to 20 meteors were seen in the course of 20 minutes all moving in the same course *westward*.

It may not at first sight be apparent how observations on a series of fireballs moving westward is going to help us in our study of another series moving eastward. If however we imagine the Canadian meteors reaching their orbit in the figure from the right at D, and sweeping around the world from the west to the Ontario station at O, at 9:00 P. M., we can then see how other meteors from the same swarm coming from the right might reach C, and later O, travelling from the east. This appears to be what happened. We simply met, or more properly speaking overtook, a widely scattered group of meteors, some of which passed within the earth's orbit, and some outside of it. Had the meteors on the other hand overtaken us, we should have had to assume two independent groups, one moving faster than the earth, and the other slower, and both lying outside of our orbit. The fact that the meteors were overtaken, and were therefore moving more slowly than the earth, shows that their orbit lay inside of ours, and that they did not belong to a comet. When two orbits of different size intersect, the bodies moving more slowly at the point of intersection are always necessarily travelling in a smaller orbit.

Let us now consider the general case of intersecting orbits. Except in the case of collision, it always requires at least two bodies, in our own case the sun and the earth, to capture a third one. Such a body may then move in an unstable orbit around the other two, but this would not be likely, especially when one was as small as the earth. What would happen would be that the third body would soon enter the field of exclusive control of one or the other larger ones. The earth's field extends outward for a distance of about a million miles, but it is only in case a body is moving in just the right direction, and with a speed practically equal to that of the earth that we could capture a meteor at such a distance and retain it. Otherwise it would leave us and continue to revolve about the sun. Again even if a meteor were moving in the same direction as ourselves, if it had the speed of a parabolic orbit about the sun we could never capture it, unless it

entered our atmosphere. In such a case it would practically always be destroyed.

On the other hand if a body should pass near the earth with less than the terrestrial parabolic velocity for that distance, it must become a satellite of the earth, and could never escape from it. Such is the present condition of our moon. We now have definite knowledge, not only that such slow speeds are possible among meteors, but also that they actually occur. This gives us definite proof that the earth *must* have meteoric satellites.

Let v be the parabolic velocity for a given distance r, then we have $U^2 = 2\mu/r$, where μ represents the mass of the earth. From this we derive that any body moving with a velocity of 5 miles per second or less, which comes within less than 7630 miles of the earth's center will be captured, and either be retained as a permanent terrestrial satellite, or be destroyed. Similarly if a body comes within 200 miles of the surface, and its velocity is less than 6.77 miles, it will be captured.

It must be understood that these velocities are measured with regard to the earth. The earth itself is moving 18.5 miles per second with regard to the sun. If everything should be favorable, we could thus even capture one of Jupiter's comets, which when reaching our orbit have a velocity of 23.51 miles per second, or 5 miles with respect to the earth. The comet would then become our satellite. It would have however to pass within 7630 miles of our center, and be moving parallel to our orbit, which would be extremely unlikely to happen, and would be so also for a meteor associated with such a comet. A body moving in the same direction as the earth, and at the same velocity 18.5 miles per second, would be 17,000 times as likely to be captured as one moving with the velocity of one of Jupiter's comets, 23.5 miles per second, and in the same direction. This is simply a question of the areas $1{,}000{,}000^2/7{,}630^2$. That bodies such as the slow moving fire balls should be continually coming within our grasp from orbits of high eccentricity, and large mean distance, in all parts of our orbit, is out of the question. That bodies on the other hand moving in orbits of small eccentricity, and at about the same mean distance as ourselves from the sun should often reach the earth's surface, in spite of our atmosphere, and might even be captured by us as satellites is very likely, and this seems to be the explanation of the great Canadian display of February 9, 1913.

FINIS.

Mandeville, Jamaica, B. W. I.,
February 1, 1923.

THE COLUMBUS ECLIPSE.

By WILLIAM F. RIGGE.

In Windsor's "Christopher Columbus" on page 465 the following incident is related.

"Columbus now resorted to an expedient characteristic of the ingenious fertility of his mind. His astronomical tables enabled him to expect the approach of a lunar eclipse (February 29, 1504), and finding it close at hand he hastily summoned some of the neighboring caciques. He told them that the God of the Spaniards was displeased at their neglect to feed his people, and that He was about to manifest that displeasure by withdrawing the moon and leaving them to such baleful influences as they had provoked. When night fell and the shadow began to steal over the moon, a long howl of horror arose, and promises of supplies were made by the stricken caciques. They hurled themselves for protection at the feet of the Admiral. Columbus retired for an ostensible communion with this potent Spirit, and just as the hour came for the shadow to withdraw he appeared, and announced that their contrition had appeased the Deity, and a sign would be given of his content. Gradually the moon passed out of the shadow, and when in the clear heavens the luminary was again swimming unobstructed in her light, the work of astonishment had been done. After that, Columbus was never much in fear of famine."

Both the historical and the astronomical parts of this incident are worthy of credence. It is the latter especially that interests the readers of these pages, and some particulars concerning it may therefore be in place.

The lunar eclipse in question was a total one with the magnitude 1.11. According to Oppolzer mid-totality occurred in 1504 March 1 at $0^h\,39^m$ in what he styles "World Time," the same as will be used in the Ephemerides in 1925 and thereafter and called Greenwich Civil Time, beginning at midnight. This is $12^h\,0^m$ fast of what at present is known as Greenwich Mean Time, which begins at noon. According to the practice still in vogue, March 1 $0^h\,39^m$ World Time is therefore February 29 $12^h\,39^m$ Greenwich Mean Time, or 6:39 P. M. Central Time. Columbus was then on the northern shore of the island of Jamaica in latitude $+\,18^\circ\,20'$ and in longitude $+\,77^\circ\,24' = 5^h\,10^m$. The local time of mid-totality was then February 29 7:29 P. M.

As the semiduration of the total eclipse was 25^m and that of the partial eclipse 103^m, we have the following schedule of the local times of the phases.

Moon enters Shadow	5:46
Total Eclipse begins	7:04
Middle of the Eclipse	7:29
Total Eclipse ends	7:54
Moon leaves Shadow	9:12*

The Sun set on that day at 6:02 local time, and the Moon rose at about 5:55, that is, about 10 minutes after "the shadow had begun to steal over it," so that, supposing the sky was clear, all the circumstances mentioned by the historian are correct, and even his phraseology cannot be criticized unfavorably.

Now the reason for mentioning this historic eclipse in the present article is a remark made by C. Flammarion towards the close of his annual address to the Astronomical Society of France on June 13 last,† that the partial eclipse of the Moon on last August 26 was a recurrence of this Columbus eclipse. He said he had received this statement from M. Judlin, who gives as his proof the fact that 5187.976 synodical revolutions and 5629.97 draconitic or nodical ones had occurred in the interval between the two eclipses. Our purpose is to study this proof. And first as to the meaning of the terms.

A synodic revolution is the time it takes the Moon to place itself again in line with the Sun or with the Earth's shadow, or in more technical language, it is the interval between successive conjunctions or successive oppositions in longitude of the Sun and Moon. The number of synodic revolutions between any two solar or any two lunar eclipses must evidently be an integral one, or at least, the difference must be within the proper ecliptic limits. The interval between dissimilar eclipses, that is, one solar and the other lunar, is obviously measured in semi-revolutions.

A draconitic or nodical revolution is the interval between successive passages of the Moon through the same node. That the number of these revolutions between any two solar or any two lunar eclipses must also be an integral one, or nearly so, within the proper ecliptic limits, is evident from the fact that the Moon's orbit is inclined to the ecliptic, in which the Sun and the Earth's shadow seem to move, so that it is only when the Moon is near the ecliptic, or near one of its nodes, that an eclipse is possible. But in this case the number may be expressed in semi-revolutions also, because dissimilar nodes, one ascending and the other descending, will produce two solar eclipses or two lunar eclipses equally well.

The *American Ephemeris* gives 29.530588 days as the mean length of a synodic revolution, and 27.212220 days as that of a mean nodical revolution. In dividing the interval of 153204 days between the Col-

*Schroeter's Correction (Sonnenfinsternisse von 600 bis 1800 n. Chr.) makes all these times two minutes later.

†L'Astronomie, July 1923 p. 304.

umbus eclipse of 1504 March 1 and that of 1923 August 26 by the above lengths, we get 5187.976 synodical and 5629.97 nodical revolutions, as M. Judlin states correctly. While the synodical revolutions are direct, the nodical ones are retrograde. But this difference has generally very little influence on the results.

The criterion that the number of the synodical revolutions between any two lunar eclipses must be integral or nearly so, and the number of nodical revolutions or semi-revolutions between these same two lunar eclipses must also be integral or nearly so, applies, as we have seen, to any two lunar eclipses whatever. What then should entitle the 1923 eclipse to the privilege of being called a recurrence of the Columbus eclipse? This third condition is that an integral number of Saroses must also have occurred between the two eclipses.

The Saros is a period of 223 synodical and 242 nodical months, after which an eclipse will recur in very much the same circumstances. This period embraces as an average 6585.32 days, or 18 years, 10 or 11 days (according as 5 or 4 leap years intervene) and 7 hours 42 minutes.* So that, 6585.32 days after the Columbus eclipse of 1504 March 1 0^h 30^m with magnitude 1.11, another very similar lunar eclipse occurred in 1522 March 12 at 8^h 27^m with a magnitude of 1.04. Astronomers would then quite generally use the expression that the *same* eclipse had recurred, that is, that the *Columbus* eclipse had recurred.

The Columbus eclipse, or the *same* eclipse may occur again after another Saros with another slight change in magnitude. This magnitude may increase to a certain maximum, after which it will diminish to zero and the series will terminate. Taking the Columbus series and writing down all the eclipses that preceded 1504 as well as those that came after it, we have the following list. This has been taken from Oppolzer's *Canon der Finsternisse*. The times are his World Times, but the magnitudes have been expressed decimally (unity meaning totality) as is the custom at present, instead of in digits or twelfths of the lunar diameter.

THE COLUMBUS SERIES.

	d	h	m	Mag.		d	h	m	Mag.
963 April	11	19	37	0.03	1179 August	19	2	17	1.82
981 April	22	2	20	0.12	1197 August	29	9	14	1.73
999 May	3	8	53	0.31	1215 September	9	16	24	1.63
1017 May	13	15	26	0.45	1233 September	19	23	40	1.53
1035 May	24	21	51	0.62	1251 October	1	7	15	1.47
1053 June	4	4	18	0.78	1269 October	11	14	57	1 41
1071 June	15	10	41	0.93	1287 October	22	22	42	1.37
1089 June	25	17	0	1.11	1305 November	2	6	44	1.34
1107 July	6	23	29	1.26	1323 November	13	14	48	1.32
1125 July	17	6	5	1.40	1341 November	23	22	58	1.29
1143 July	28	12	38	1.57	1359 December	5	7	15	1.28
1161 August	7	19	23	1.70	1377 December	15	15	31	1.27

*The Lunar Saros, Pop. Astr. xxvi 85.

	d	h	m	Mag.		d	h	m	Mag.
1395 December	26	23	52	1.26	1558 April	2	23	42	0.90
1414 January	6	8	11	1.25	1576 April	13	7	9	0.80
1432 January	17	16	25	1.26	1594 May	4	14	33	0.70
1450 January	28	0	38	1.22	1612 May	14	21	48	0.58
1468 February	8	8	48	1.18	1630 May	26	5	0	0.44
1486 February	18	16	47	1.16	1648 June	5	12	14	0.33
1504 March	1	0	39	1.11	1666 June	16	19	22	0.21
1522 March	12	8	27	1.04	1684 June	27	2	30	0.06
1540 March	22	16	10	0.98					

We see that the series beings with the eclipse of 963 April 11 with a magnitude of 0.03. A Saros length before that, 945 April 1, shows no eclipse, nor do many such intervals before it, so that the eclipse of 963 April is the first of the Columbus series. Following this eclipse at the regular intervals of 18 years 10 or 11 days (the 7 hours 42 minutes being only a *mean* length), we see that the magnitude rises as high as 1.82, and that the series terminates with the eclipse of 1684 June 27 with the magnitude 0.06, embracing in all 41 eclipses.

That the series really terminates and does not revive, may be seen if we take its last eclipse 1684 June 27, and add the usual Saros intervals, only neglecting the hours and minutes as immaterial for our purpose. We then have the following series of what we might call vacant eclipses.

1702	July	8	1810	Sept.	9
1720	July	18	1828	Sept.	20
1738	July	29	1846	Oct.	1
1756	Aug.	8	1864	Oct.	11
1774	Aug.	19	1882	Oct.	22
1792	Aug.	29	1900	Nov.	2

The last vacant eclipse here given has the date 1900 November 2, but instead of on November 2, which should have been the date if the series revived, we had a real eclipse on June 13 in that year at $3^h\ 24^m$ with a magnitude of 0.02, which began a new series, two of the following ones being 1918 June 24 $10^h\ 28^m$, 0.16, and 1936 July 4, $17^h\ 28^m$, 0.28.

This new series is neither a revival of the Columbus series on account of the jog of six months in 1900, nor has it an eclipse in 1923.

And lastly, taking the eclipse of 1923 August 26, mag. 0.17, and studying its series, we find that this terminates with the next eclipse 1941 Sept. 5, mag. 0.06. It began in 1419 April 10, with the magnitude 0.05, at about the middle of the Columbus series. There could surely not be two Columbus series running together half the time. The 1923 series has no eclipse in 1504, the nearest to it being 1509 June 2, mag. 0.64, which is 5 years and 3 months away.

The eclipse of 1923 August 26 can therefore in no sense be said to be a recurrence of the Columbus eclipse.

THE ASTRONOMICAL SYSTEM OF COPERNICUS.

By W. CARL RUFUS.

The problem of representing the motions of the heavenly bodies baffled the world's greatest thinkers for two thousand years. Its solution required the combined effort of a host of observers, geometers, theorists and computers, from the days of the Greek philosophers to the time of Newton. The pioneer of the international group of scientists, who solved the problem, was Copernicus, a Pole (1473-1523). He was followed by Tycho Brahe, a Dane (1546-1601); Kepler, a German (1571-1630); Galileo, an Italian (1564-1642); and Newton, an Englishman (1643-1727). The law of gravitation, which is the key to the solution, has been universally considered to be the greatest scientific generalization of the human mind.[1]

The solution of the problem demanded an underlying astronomical system in harmony with the facts of nature and the construction of the universe, not merely an arbitrary system that would "save the phenomena." The heliocentric system of Copernicus met that requirement in general, although Kepler's elliptical orbits were an indispensable correction.

Three of the most important astronomical systems[2] were advocated by Ptolemy (2nd century B. C.), by Copernicus and by Tycho Brahe.

The Ptolemaic system is geocentric. Developed by the Greek philosophers it held undisputed sway from the second to the sixteenth century. The motionless earth at the center is surrounded by the four sublunary elements, which we need not consider, and is encircled by the spheres of the seven planets of the ancients in the order indicated, —Moon, Mercury, Venus, Sun, Mars, Jupiter and Saturn. Outermost is the sphere of the stars. The last sphere rotates daily about the earth from east to west imparting its motion to those within, and in this way carrying all the heavenly bodies around the earth once a day. The spheres of the planets rotate in the opposite sense; the greater the distance, the longer the period, Saturn, approximately 30 years, Jupiter, 12 years, Mars, 2 years, 1 year for the Sun, Venus and Mercury, and one month for the Moon. Some details of the motions will be considered later.

[1] If Einstein's theory of generalized relativity should meet the tests of astronomy and physics for the next two hundred years, this statement will need to be modified.

[2] Excellent illustrations may be found in Cellarius' Harmonia Macrocosmica, 1708.

The system of Copernicus is heliocentric. The Sun is motionless at the center, around which revolve the planets, Mercury, Venus, Earth, Mars, Jupiter and Saturn. The Moon revolves about the Earth and accompanies it in its journey around the Sun. Surrounding all is the sphere of the stars which is at rest, its rotation from east to west being replaced by the rotation of the earth on its axis in the opposite direction.

The system of Tycho Brahe is an ingenious compromise. The earth is motionless at the center surrounded by the orbit of the Moon and the orbit of the Sun. The Sun is encircled by the orbits of the remaining planets, Mercury, Venus, Mars, Jupiter and Saturn. The sphere of the stars is outermost and rotates daily about the central Earth.

The fundamental principles of these three astronomical systems developed side by side during the constructive period of Greek astronomy, but the Ptolemaic finally prevailed.

Before the Greek period the ancient races, including Chaldaean, Egyptian, Indian and Chinese, had made extensive observations chiefly for astrological use. They possessed a remarkably accurate knowledge of the apparent movements of the sun, moon and planets, including the length of their periods. The Chaldaeans discovered the saros, or restitution period, which they used in predicting lunar eclipses. The Babylonians added a more refined method of celestial measurements introducing the sexagesimal system which is used today. Assuming the constant value of the sidereal day they determined the length of the natural time units. Hipparchus (2nd century B. C.), the greatest Greek astronomer, obtained from them the lengths of the sidereal, synodic, anomalistic, and nodical months. In their observations they used the sundial, clepsydra, astrolabe, and gnomon. Little was contributed by the Egyptians bearing upon our problem, excepting their system of earth measurement or geometry; which was improved by the Greek mathematicians and provided a method of attacking celestial motions.

The observed motions of the heavenly bodies which challenged the mind of man included the daily rotation of the entire celestial sphere from east to west carrying the fixed stars and other heavenly bodies; the monthly revolution of the moon eastward through the zodiacal constellations, accompanied by change of appearance; the annual revolution of the sun, accompanied by change in midday altitude associated with the seasons; and the periodic revolutions of the planets, whose apparent paths have stationary points and retrogressions producing loops or convolutions.

Plato, (about 428-347 B. C.) according to Sosigenes,[3] "set it as a problem to all earnest students to find 'what are the uniform and ordered movements by the assumption of which the apparent movements

[3] Heath, Aristarchus of Samos, p. 140.

of the planets can be accounted for'." Eudoxus (409-356 B. C.), a pupil of Plato, was the first to make an hypothesis and to test its scientific value by the agreement between theory and observation. His assumption of uniform circular motions to explain the movements of celestial bodies was retained two thousand years; Copernicus made use of it in his astronomical system. The homocentric spheres of Eudoxus with the earth at the center accounted for the most outstanding features of planetary motion, but failed to account for the varying distance. Aristotle, however, adopted this system and gave the spheres material existence.

The system of Philolaus (5th century B. C.), a Pythagorean, removed the earth from the center and put in its place an imaginary central fire, around which revolved the spheres of the planets among which was placed the earth. To complete the perfect number ten, an imaginary counter-earth was added. The velocities of the bodies depended upon their harmonic distances in the Pythagorean system, the nearer being the slower and giving out a lower tone. Thus the "music of the spheres" originated. The system was purely imaginary. The significant features are that the earth was removed from the central position and was put in motion with the planets.

Hiketas, and Ekphantus (5th century B. C.), other Pythagoreans, rejected the system of Philolaus and advanced the idea that the heavens, sun, moon, and planets, are standing still, while the earth turns like a wheel from west to east.

The first limited heliocentric idea was clearly given by a Platonic scholar, Heraclides of Pontus, (4th century B. C.). In his system the earth rotates on its axis at the center of the world. The sun revolves about the earth; also the outer planets are geocentric. The unique feature is that Mercury and Venus revolve about the sun. This system is sometimes called the Egyptian. Copernicus referred to it as the system set forth by Martianus Capella (5th century A. D.). It solves the question of the relative distances of Mercury and Venus, which had given much difficulty to the ancients. It also explains why they always appear within a limited angular distance of the sun. The heliocentric idea was extended to include Mars by Riccioli (1598-1671) and to include all the planets by Tycho Brahe as previously seen, although Tycho did not adopt the rotation of the earth. Schiaparelli[4] concludes that Heraclides was the inventor of the system of Tycho, or was acquainted with it. His speculations go farther and credit Heraclides with originating the Copernican hypothesis. Heraclides used two epicycles with centers at the sun to define the motion of Mercury and Venus.[5]

Aristarchus of Samos (3rd century B. C.) deserves full credit for

[4] I precursori di Copernico.

[5] Heath, Greek Mathematics. Vol. I, p. 317.

originating the heliocentric hypothesis. Heath,[6] who made an exhaustive study of the subject, concludes: "There is not the slightest doubt that Aristarchus was the first to put forward the heliocentric hypothesis." Copernicus seems to have known something of the work of Aristarchus to which he referred in a passage in his manuscript of De Revolutionibus, which he afterward suppressed, and in other writings, e. g. the letter of Lysius. Archimedes, a contemporary of Aristarchus, gives conclusive evidence concerning the hypothesis. Referring to a work by Aristarchus he says: "His hypotheses are that the fixed stars and the sun remain unmoved, that the earth revolves about the sun in the circumference of a circle, the sun lying in the middle of the orbit, and that the sphere of the fixed stars, situated about the same center as the sun, is so great that the circle in which he supposes the earth to revolve bears such a proportion to the distance of the fixed stars as the center of the sphere bears to its surface." Archimedes, a keen mathematical critic, here objects to the use of the ratio of a point to a spherical surface. There is no question, however, concerning the content of the heliocentric hypothesis. Even the comparison of the size of the earth's orbit with the sphere of the stars bears a close resemblance to the doctrine of Copernicus. Seleucis, a Babylonian, about a century later, also maintained the truth of this system.

Apollonius extended the use of epicycles to the outer planets, but it involved the assumption of a moving point as center of the epicycle not marked by a moving body. Eccentrics as deferents were also applied to the outer planets. Apollonius recognized that the motion of the center of the eccentric moved in the same direction and at the same speed as the sun. Combined with the heliocentric epicyles of Mercury and Venus a system resembling that of Tycho Brahe would result, with one improvement, the daily rotation of the earth. Heath concludes that this system was anticipated by some one between the time of Heraclides and Apollonius or perhaps by Apollonius himself and adds: "If it was, then Apollonius (coming after Aristarchus of Samos) would be exactly the Tycho Brahe of antiquity." We might add that Ursus[7] (?-1600) ascribed Tycho's system to Apollonius.

Hipparchus (2nd century B. C.) improved the theory of solar and lunar motion and developed a system of eccentrics and epicycles which satisfied their apparent motions. According to Ptolemy he was the first to point out the difference between the value of the maximum anomaly and the radius of the epicycle. On account of the lack of satisfactory observations, he gave up planetary theory, made observations, and accumulated records for his successors.

Ptolemy (2nd century A. D.), the last great astronomer of the

[6] Aristarchus of Samos, the Ancient Copernicus, p. 301.

[7] Reymers Bar. Referred to by Sherburne. The Sphere of Manilius. Appendix, p. 135.

Greeks, perfected the geocentric system, improved lunar theory by adding evection, and extended the detailed application of epicycles and eccentrics to the planets. He proved the identity of the hypotheses of eccentric and epicycle previously indicated and used an eccentric deferent for the first inequality of motion, or the equation of the center. He also introduced the equant, which violated the principle of uniform circular motion, as the motion in the deferent is uniform not about its center nor about the earth but about the equant. But he brought about an agreement between theory and observation that was not seriously questioned until the time of Copernicus. In his system, he placed the centers of the epicycles of Mercury and Venus on a line between the earth and the sun. After Ptolemy came the stationary period in the history of astronomy in Europe.

Greek astronomy traveled eastward and found adherents in India and Arabia. In India, one significant feature was added to the epicycle. Its radius was variable, being greatest at perigee and apogee and least at 90 degrees from these points. The result was an oval or elliptical epicycle. Aryabhata (b. 476 A. D.) also held the doctrine of the rotation of the earth; but this was rejected by Brahmagupta. The revolutions of the planets were geocentric, however, and their motions inextricably related to the complicated theogony of the Hindus.

Indian astronomy influenced by the Greeks appears to have been the precursor of Arabian medieval science. Later the Arabs obtained original Greek works including the Syntaxis of Ptolemy, the ancient astronomical classic. Little was added by them and nothing that bears directly on our subject excepting the fact that Albategnius, (?-929), placed Mercury below the sun and Venus above.

Alfonso X of Castile, (1223-1284), and his astronomers in the production of his celebrated tables were dependent upon the Ptolemaic system. The elliptical form of the deferent of Mercury in an illustrative figure is interesting.

Astronomy was the first science to respond to the revival of learning in Europe during the fifteenth century. Nicolaus de Cusa (1401-1464) in his mystical philosophical work, De Docta Ignorantia, (1440), appears to hold that the earth is moving. The universe is infinite so it has no center and no circumference. An observer on the earth, on the sun, or on any other body, would consider himself at rest and all other objects in motion. This has a very modern relativity aspect.

Peurbach (1426-1461) and his more illustrious pupil, Johann Muller (1436-1476), (Regiomontanus), reverted to Ptolemy and recovered Greek writings to supplement Arabic translations.

Calcagnini of Ferrara, (1479-1541), a contemporary of Copernicus, taught the daily rotation of the earth and attempted to explain all apparent motions of the celestial bodies by tiltings of the earth leaving it at the center of the universe. Vague, speculative ideas concerning the motions of the earth were held by others.

It remained for Copernicus to give definite form and content to these speculations and to develop a complete system of astronomy, in which the motions of the earth played the decisive part in solving the problem of celestial motions.

The training of Copernicus was cosmopolitan and gave him balance and breadth of view as well as technical preparation for his task. At the University of Cracow (1490-1494) he had the best teacher of mathematics and astronomy in northern Europe, Albert of Brudzew, (?-1495), who was familiar with all the details and difficulties of the Ptolemaic system. He used the works of Peurbach and Regiomontanus and wrote a commentary on Peurbach's *Theorica Novae Planetarum*. At Bologna (1497-1500), as a student of canon law, Copernicus studied Greek, read Plato, and became intimately acquainted with Novara, the astronomer. Here he made his first recorded observation, an occultation of Aldebaran, March 9, 1497. During the jubilee year, 1500, in the city of Rome, he gave lectures on "mathematics," which meant astronomy, but it is not clear what position he held. Here he observed a lunar eclipse. In 1501, he entered Padua to study law and medicine. He probably discussed planetary motions with Fracastoro, who held a chair of logic, and afterwards attempted to revise and to revive the theory of homocentric spheres.

Nine years in Italian centers of learning, where astronomy held an eminent place, gave him possession of the best astronomical knowledge and the most advanced theories of the day. Berti,[8] tracing the effect of his Italian training upon his nascent ideas, emphasises the great influence exerted by Novara with whom Copernicus lived in Bologna according to the prevailing custom of pupil and teacher. He infers that it was under the guidance of Novara that Copernicus began to collect the materials which he used later to construct his system. He also says: "It is beyond doubt that the frequent discourses which our (Italian) scholars made with more or less clarity, contributed to set his attention on the motion of the earth." He concludes, however, that "The system of Copernicus is the signal work of his own mind. *Esso e suo, tutto suo.* (It is his, entirely his.) Great systems, such as this one, are not piecings together of anonymous works."

When Copernicus returned from Italy in 1506, he was a learned mathematician, a doctor of canon law, and a doctor of medicine. He had previously been appointed a secular canon of the church and in the following year became permanent physician to his uncle, the Bishop of Ermland. Astronomy was his avocation.

Not only was Copernicus well prepared for his work, but the time was opportune. Revolutionary changes were in vogue. Gutenberg's invention had provided movable type and printing presses were busily

[8] Copernico e le vicende del Sistema Copernicano in Italia, kindly reviewed by Professor McLaughlin.

engaged spreading new ideas. Columbus discovered a new world and the ships of Magellan circumnavigated the globe. Savonarola preached his prophetic warnings and Martin Luther nailed his theses to the Wittenberg cathedral door. Aristotle's authority in science was beginning to be questioned. The old everywhere was being challenged and the new was being tried.

Copernicus, in his introductory letter of De Revolutionibus to Pope Paul III, says that he became dissatisfied with the complicated astronomical systems of his day. He began to doubt concerning the motions of the sun, the moon and the planets, because mathematicians disagreed in their results and were even unable to prove by observations the constant length of the year. Some used concentric circles, others eccentrics and epicycles and contradictions to the first principles of uniform motion were introduced. To quote: "Nor have they been able to discover or calculate from these (methods) the main point, which is the shape of the world and the fixed symmetry of its parts; but their procedure has been as if someone were to collect hands, feet, a head, and other members from various places, all very fine in themselves, but not proportionate to one body, and no single one corresponding in its turn to the others, so that a monster rather than a man would be found from them." He thought that "something essential" had been omitted, some harmonizing factor, and set about to find it. Distrusting current methods and their disgusting inconsistencies he turned to the old philosophers and found that some held the opinion that the earth moves. Taking this as a starting point he began to construct his system.

We do not know when he first conceived the heliocentric idea. Undoubtedly he held it as an hypothesis when he returned from Italy in 1506. It is quite probable that he had heard of speculations concerning the mobility of the earth in Cracow and may have gone to Italy to study Greek to be able to read the philosophers. The details of the system were worked out, put in manuscript form, and lay in the study according to his own words "not nine years but going on four times nine." In that case, as De Revolutionibus appeared in 1543, the system must have been perfected soon after his return from Italy. His "Commentariolus," a manuscript for private circulation setting forth the essential principles of his system without the proofs, was prepared about 1530. In 1531, on account of his absurd ideas, he was ridiculed on the stage at Elbing, where he was well known. However, concerning slanderers and idle talkers he says: "I care not at all; I will even despise their judgement as foolish." He desired the candid opinion of able critics and had confidence that ingenious and learned mathematicians would sustain him if they were willing to recognize and weigh the matters adduced to demonstrate his system. But he adds very suggestively: "Mathematics are written for mathematicians."

Copernicus attacked the problem of the motion of the heavenly

bodies with the same kind of observational material at hand, similar means of observation, and with the same geometrical method of approach, which were used by the Greek philosophers and became the common inheritance of Indians, Arabs and Europeans. He retained the venerable assumption of uniform circular motions, discarding the equant of Ptolemy which violated that principle. He retained eccentrics and epicycles, some of which acquired new significance. He made some observations but was not an accurate observer.

What then was the secret of his success? In a quotation above one expression is a revelation. He refers to "*the main point*, which is the shape of the world, and the fixed symmetry of its parts." His problem was not to save the phenomena, but to reveal nature. When he found the true system, to be sure, the phenomena took care of themselves. What was the failure of the Ptolemaic system? When the centers of the epicycles of Mercury and Venus were removed from the sun to imaginary moving points reality ceased to be the goal. The simplicity of natural processes was eclipsed by complex artificiality. We must remember that Copernicus retained too much, even more than was necessary, of this scaffolding, which Kepler finally removed.

In the system proposed by Copernicus the world is spherical. The earth is also spherical as held by the Greeks after Pythagoras. Copernicus departs from the idea of the sublunary elements and makes earth and water constitute one sphere. His use of circular motions is justified by these words: "We must confess that the celestial motions are circular, or compounded of several circles, since their inequalities observe a fixed law and recur in value at certain intervals, which could not be, except that they were circular; for a circle alone can make that which has been, recur again." He then uses the Aristotelean argument of the unchangeable mover or motive power to account for the uniformity of the motion. He makes a clear analysis of relative motion and applies it to show that the diurnal rotation of the celestial sphere may be explained equally well by a rotating sphere and a stationary earth or by a stationary sphere and a rotating earth, as taught by Heraclides and Ecphantus. He thinks that it is more reasonable to believe in the daily rotation of the earth a mere point in comparison, than to maintain that the sphere of the stars is revolving at an inconceivable speed.

In removing the earth from its central position he had the example of Philolaus and others, although he presents original reasons. The center was "the natural place" as Aristotle had proved, since all parts tend to the center; but Copernicus extended that principle and found other centers in the sun, moon and planets. Then if the earth is moving out of the center its motion must be revealed by the principle of relative motion in the apparent motions of the other bodies. The problem of fixing the orbits of Mercury and Venus may have given Copernicus his clue to the heliocentric motion of the planets. After

discussing the difficulty he says: [9] "Therefore, I think the opinion set forth by Martianus Capella and some other Latin writers is not to be despised. For he supposes that Venus and Mercury travel round the sun and therefore cannot get farther away from it than the convexity of their orbits allows, since the latter do not surround the earth. The sun, therefore, is the center of their orbits." This as we have seen was the unique feature of the system of Heraclides. He continues: "If we take occasion of this to refer Saturn, Jupiter, and Mars, to the same center, bearing in mind the great extent of their orbits which enclose the two planets as well as the earth, we shall not fail to find the true order of their motions."

He next places the earth with the moon as satellite between the orbits of Venus and Mars where a great space was left and makes it revolve about the sun. Again applying relative motion he reaches the conclusion that what appears to be a motion of the sun is in truth an annual revolution of the earth and thus the motionless sun occupies the center of the universe. This arrangement accounts for the stationary points, retrograde arcs, and convolutions of the planetary orbits; these irregularities are therefore merely apparent, while the true orbits are simple and natural.

Two motions of the earth, however, were insufficient for Copernicus, a third was necessary to take care of the direction of the axis of rotation of the earth. For this third assumption he has been harshly criticized by his opponents and partially pardoned by his followers. Dreyer[10] is "almost reconciled" to the "needless third motion of the earth," because in its consideration Copernicus contributes the correct explanation of the precession of the equinoxes. We are not only entirely reconciled; but we believe that this third assumption was a master stroke of his genius. His problem was to find out the mechanism of the universe; this he attempted to do by interpreting observational data on the hypothesis of motions of the earth. The first motion of the earth, its diurnal rotation, took care of the apparent motion of the outermost sphere of the stars. The second motion of the earth, its annual revolution about the sun, took care of the sun's apparent orbit, and in connection with the heliocentric revolution of the planets it explained their peculiar apparent motions. There remained one unexplained phenomenon, the precession of the equinoxes, discovered by Hipparchus, which might have been taken care of by a motion of the outer sphere; but Copernicus faced the problem of explaining it by a third motion of the earth, and that was accomplished. It is unfortunate that this motion is so involved in the method of defining the motion that the main point has not been more clearly emphasized. Copernicus was limited in his mathematical analysis to the geometrical

[9] Dreyer, History of the Planetary Systems, p. 326.
[10] History of the Planetary Systems, p. 329.

method of his day. This was based upon the Aristotelian doctrine of solid revolving spheres, so the frame of reference was fixed in the moving sphere. Consequently, in defining the direction of the axis of the earth, Copernicus used for the initial line the radius vector of the center of the earth.[11] His keen analysis detected the difference between the annual component due to the moving radius vector and the small component due to precession, which is correctly explained by the third motion of the earth. This is a real motion and is so accepted by astronomers today. A complicated fourth motion due to nutation has also been added.

The system of Copernicus, when applied to planetary motions, provided a means for a true interpretation of the chief geometrical constructions. For example, in the case of the inner planets, the deferent of Ptolemy became unnecessary, while the imaginary epicycle became the real orbit. In the case of the outer planets, the first epicycle of Ptolemy, which was merely a counterpart of the earth's orbit, became unnecessary, which led to simpler constructions. Inequalities were taken care of by eccentrics and epicycles, with this essential difference: they represented residuals or corrections to real quantities, which, in the words of Copernicus: "observe a fixed law and recur in value at certain intervals." The resultant true orbit referred to the sun, was free from the convolutions which were readily explained as apparent motion due to the combined motion of earth and planet. This sense of reality became evident also because the system provided a means of determining the relative distances of the planets from the sun or the relative sizes of the orbits; which was not done by Ptolemy; because each geocentric orbit was determined independently of the others and the essential unifying factor lay hopelessly concealed. That undiscovered quantity was the radius of the earth's orbit about the sun, which was involved in each geocentric orbit, being represented by the radius of the deferent in the case of the inner planets and by the radius of the epicycle in the case of the outer planets. The heliocentric system was necessary to reveal this common quantity and to interpret its true meaning.

To obtain the mean distances of the planets from the sun, Copernicus needed an observation of each outer planet at opposition and at one other position and an observation of each inner planet at greatest elongation. In the observations made by Copernicus and recorded in "De Revolutionibus" there are three at opposition of each outer planet and one at another position, but there is none of the inferior planets at elongation, the observations of others being used in this case. He observed an occultation of Venus; but left no recorded observation of Mercury. That does not mean that he never saw Mercury, a statement that persists even among astronomers.

[11] Diagram, De Revolutionibus, p. 32, Thorn, 1873.

The values of the mean distances compared with modern values are as follows:

	Copernicus	Young
Mercury	0.3763	0.3871
Venus	0.7193	0.7233
Earth	1.0000	1.0000
Mars	1.5198	1.5237
Jupiter	5.2192	5.2028
Saturn	9.1743	9.5389

The observations of Copernicus were made with a "triquetrum," a Ptolemaic instrument for measuring zenith distances, which he constructed of three strips of deal. The first stood upright, with a second hinged near its top to direct toward the star, and a third extending from the first to the second and graduated to read the angle between them. He did not obtain a high degree of accuracy, which seemed to trouble his disciple, Rheticus. One fundamental star was in error 40′. All he hoped to attain, however, was approximate agreement between observation and theory sufficient to test the truth of his system. He told Rheticus that he would be as happy as Pythagoras when he discovered his theorem, if he could get agreement between his theory and observations within 10′ of arc.

He made maximum use of his own observations and others. From determinations of the apogee of the outer planets based on Ptolemy's observations and his own, he discovered[12] the motion of the line of apsides. His values were in error, however, as he kept too close to the old geocentric theory, using apogee instead of aphelion and referring the motion of the line of apsides to a line through the center of the earth's orbit instead of a line through the sun. Kepler made the necessary corrections.

Although Copernicus obtained the relative distances of the planets with fair accuracy and could thereby represent the system on an arbitrary scale, he went far astray regarding the absolute values. For the sun's mean distance, using data from Ptolemy with slight modifications, he obtained 1142 times the earth's radius, a value less than 1/20 of the true distance.

An inherent defect in his system was the use of epicycles, or uniform circular motions, as it is impossible to select a system that will correctly represent at the same time both the direction and the distance of a moving body. His system also appeared complex, requiring 34 circles in all; 4 for the moon, 3 for the earth, 7 for Mercury, and 5 for each of the remaining planets. Some of these were involved in correcting planetary motions due to his referring them to a line related to the earth. He had not entirely freed his heliocentric theory from the imperfection of the geocentric. Copernicus, however, appears to be elated with the reduction of the number of circles for he says:

[12] Albategnius discovered that the apogee of the sun had changed from the position given in the Almagest. Berry, A Short History of Astronomy, p. 79.

"Thus altogether 34 circles suffice to make plain the entire structure of the world, the whole round-dance of the stars.[13]

In contrast to this "complex" system which reaches the enormous (?) number of 7 circles to explain Mercury's motion, we may compare the modern analytical method. With Kepler's elliptical form of orbit and employing series composed of circular functions to take care of inequalities, Brown finds it necessary in defining the motion of the moon to employ 1500 terms!

Two real objections confronted the system. If Mercury and Venus revolved about the sun they ought to show phases like the moon. If the earth revolved about the sun, the stars should change their apparent position, i. e. they should have an annual parallax. Copernicus merely replied: "Have patience, time will tell." Galileo's telescope revealed the first. Nearly 300 years elapsed before Henderson and Bessel removed the last objection.

The astronomical system of Copernicus as he left it did not completely solve the problem of the motion of the heavenly bodies. With the sun at the center of planetary motion it provided a firm foundation for future work. More accurate and more systematic observations were needed to provide the data for a purely formal solution. Tycho Brahe, although he did not adopt the Copernican system, supplied this demand. A keener scrutiny of the observational data, combined also with a speculative daring untrammeled by the traditions of the past, was necessary to break from the metaphysical assumption of uniform circular motion and to give the true form of planetary orbit. This was done by Kepler, whose empirical laws of planetary motion based upon the ellipse gave the formal solution or definition in terms of space and time. And yet the problem was not completely solved. The baneful effect of authority in science had to be finally overpowered and nature itself enthroned as the true source and final arbiter of natural law. Galileo's dramatic appeal at the leaning tower of Pisa from the authority of Aristotle to the authority of nature paved the way. Inheriting only medieval erroneous or obscure ideas he swept them aside and laid the foundation of dynamical physics. New mathematical methods had to be devised, analysis developed, and computation improved, to keep pace with the accuracy of accumulated data. These needs were met by the generalized coefficients of Vieta, the coördinates of Descartes and the logarithms of Napier. Finally, a master genius had to gather up all these related factors, data, dynamics and analysis, improve them where they proved inadequate for his task and apply them on the foundation laid by Copernicus and perfected by Kepler to obtain the final analytical solution in terms of physical quantities. This was done by Newton who found the law of gravitation, which binds the heavenly bodies together, defines their motions and consti-

[13] Prowe, Nicolaus Coppernicus, Vol. II, p. 292.

tutes the "essential something" which escaped the ancient philosophers and Copernicus helped to find.

OBSERVATION OF THE HEAVENS.

By FREDERIC R. HONEY.

One of the difficulties with which the observer of the heavens contends is his inability to realize his own position in space, which depends upon his latitude and longitude; his position relative to the plane of the ecliptic, which is dependent upon the time of the day or night when the observation is made; and the earth's position in its orbit.

There are many questions which are readily answered by the student who is familiar with the elementary problems of descriptive geometry. For example, if it is required to represent the horizon plane of a place of which the latitude and longitude are known, he will see at once that the problem is *to pass a plane tangent to a spheroid at a given point on its surface.* All objects which are on one side of this plane, including one half of the celestial sphere, are within the range of vision; and those on the other side are invisible. This plane, extended indefinitely, intersects the celestial sphere in a great circle which, in the language of perspective, is *the vanishing line of the plane*, and of all planes which are parallel to it. It is therefore the vanishing line of the horizon plane of the antipode, where the other half of the celestial sphere comes within the range of vision. In proportion to the practically infinite magnitude of the celestial sphere, the earth shrinks to a mere point, and these horizon planes, which are separated by a distance of nearly eight thousand miles, coalesce at the surface of the celestial sphere.

Or the question may be asked: Why is it that the sun, the moon, or a planet, crosses the meridian at an altitude above the horizon which varies greatly during the year? It will be understood that, since the moon and the planets are never very far from the ecliptic, the principal cause of their variable altitude is the inclination of the earth's axis.

It should be noted that in the illustrations no account is taken of the effect of refraction in apparently raising a celestial body above the horizon. And in a drawing of these dimensions the earth is represented by a circle. If it be made on a large scale, the following dimensions, or multiples of them, may be employed. Represent a mile by a fraction of an inch (0.003). Thus *3963.34 (the equatorial radius)* $\times$ *0.003* $=$ *11.89 inches;* and *3949.99 (the polar radius)* $\times$ *0.003* $=$ *11.85 inches.* Constructed on these axes, or semi-axes, the oblate spheroid may be represented by four arcs of circles.

Observations of the Sun.

Fig. 1 is the projection of the earth on a plane which contains its axis, and which is perpendicular to the plane of the ecliptic. The axis is inclined to the ecliptic at an angle of $66° 33'$; and the equator at an angle of $23° 27'$. The observer's position is that of New York City (lat. $= 40° 48'$). He is at a when the sun is crossing the meridian at the date of the summer solstice when the earth's heliocentric longitude is 270°; and at b at that of the winter solstice (long. 90°). His distance from the plane of the ecliptic is so small in comparison with the sun's

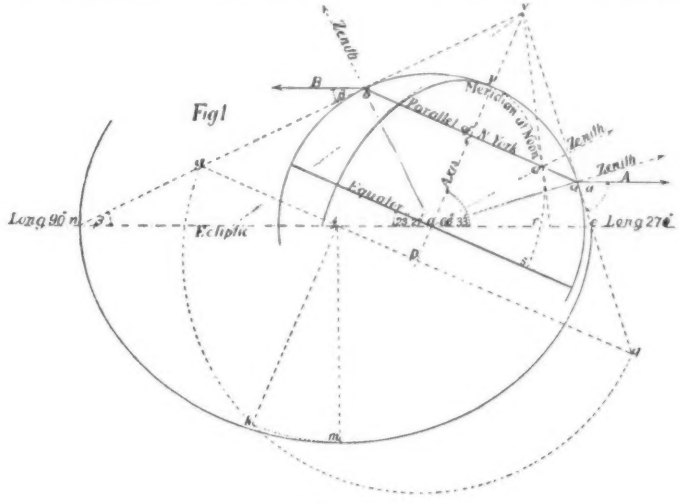


Figure 1.

distance—less than the solar parallax—that the arrows A and B which indicate the directions in which the sun's centre is seen, are apparently parallel to the ecliptic. The tangents ve and vn are the vertical traces of horizon planes; and the angles α and β are respectively the altitudes of the sun's centre above the horizon at the dates of the summer and winter solstices.

The tangents ve and vn may be considered as elements of a cone which is tangent to the earth along the parallel ab, which intersects the plane of the ecliptic represented by ne in one projection, and by the ellipse nme in the plane of the ecliptic. To draw this ellipse, bisect ne at the centre f. Through f draw gq perpendicular to the axis. From the centre p with the radius pg describe the semi-circle gkq. Draw fk parallel to the axis, and make the semi-minor axis $fm = fk$. The ellipse may be represented by eight arcs of circles. The traces of all horizon planes at the latitude of New York are tangent to this ellipse.

The construction of Fig. 2 explains how to determine the sun's

altitude at noon for any day of the year; and since the accuracy of the drawing depends partly upon that of Fig. 1, attention is called to the following trignometrical checks. Calling the earth's radius r, the distance from the equator to the parallel $oc = r \times sin\ 40° 48'$; and the radius of the parallel $ca = r \times cos\ 40° 48'$. The distance to the vertex of the cone $ov = r \times sec\ 49° 12'$ (comp of latitude); $oe = r \times sec\ 17° 21'$ $(40° 48' - 23° 27')$; and $on = r \times sec\ 64° 15'$ $(40° 48' + 23° 27')$.

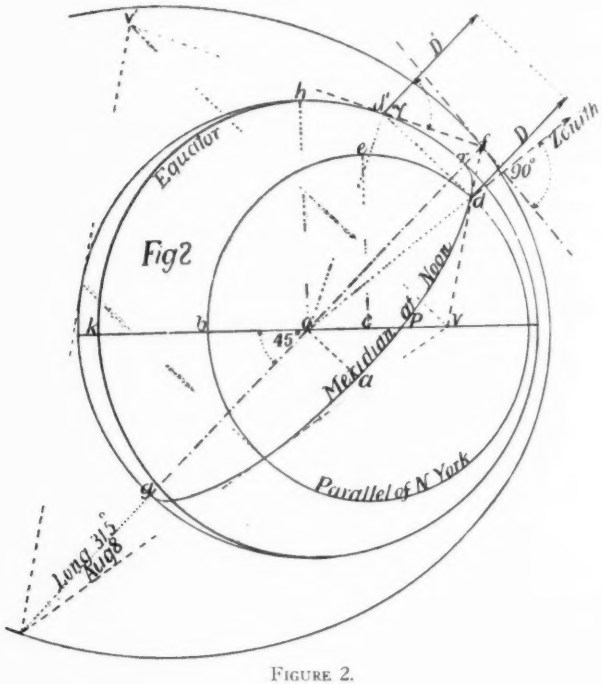


FIGURE 2.

Fig. 2 is the projection of the northern hemisphere upon the plane of the ecliptic on Aug. 8 when the earth's heliocentric longitude is 315°. To draw the projection of the meridian at noon, make $oP = oP$ (Fig. 1) $\times\ cos\ 66° 33'$. Having given the semi-major axis og and the point P, the length of the semi-minor axis oa may be found by a simple construction. The projection of this meridian in Fig. 1 is found as follows: make or, the distance to the point where the meridian pierces the plane of the ecliptic $= r\ cos\ 45°$; and having given the semi-major axis oP and the point r, the semi-minor axis os may be found as before. The projection of the equator is the ellipse whose semi-major axis is

$oh = r$, and the semi-minor axis $ok = r \times cos\ 23° 27'$. The distance to the centre of the parallel $oc = oc$ (Fig. 1) $\times cos\ 66° 33'$; the semi-major axis $ce = ca$ (Fig. 1); and the semi-minor axis $cb = ce \times cos\ 23° 27'$.

The position of the observer is at d where the meridian and parallel intersect; and since the direction in which the sun's centre is seen is practically parallel to the plane of the ecliptic, the arrow D, indicating that direction, is drawn parallel to gr the trace of the plane of the meridian. If this plane be rotated about its trace until it comes into the plane of the ecliptic, the point d will come to the position d' on the circumference of the great circle; D' is parallel to D; and the angle γ between D' and the tangent $d'f$ gives the altitude of the sun's centre at noon.

The distance from o to v, the projection of the vertex of the cone, is equal to ov (Fig. 1) $\times cos\ 66° 33'$. The drawing should stand the

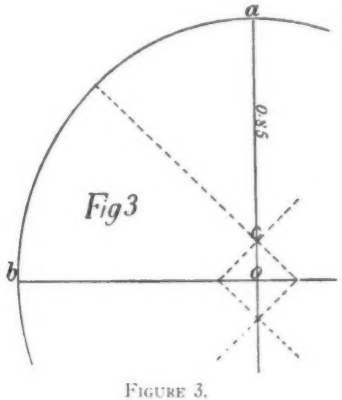


FIGURE 3.

following tests. The tangents $d'f$ and vdf should intersect at f where the trace of the plane of the meridian intersects the base of the cone; and the trace of the horizon plane on the plane of the ecliptic which is tangent to the ellipse at f, should be perpendicular to the projection of the arrow directed to the zenith. *If a line is perpendicular to a plane, its projection is perpendicular to the trace of the plane.*

Since the equator and the parallels are inclined to the plane of the ecliptic at the same angle, they are projected in similar ellipses; that is to say the proportion between the major and minor axes is constant, and is very nearly that of *12 : 11*. The minor axis is equal to the major multiplied by the cosine of 23° 27′; thus $0.91741 \times 12 = 11.0089$.

Fig. 3. When the drawing is made on a small scale the ellipse may be represented by four arcs of circles. With a radius ca equal to eighty-

five hundredths of the semi-major axis, describe the arcs which pass through the vertices of the major axis. These arcs are limited by 45° lines which are produced to intersect the minor axis at the centres from which the arcs passing through the vertices of the minor axis are described.

The student may find the sun's altitude at noon for any other date, as for example, that of either the vernal or autumnal equinox.

THE OCCULTATION OF ALDEBARAN 1923, NOVEMBER 23-24.

By WILLIAM F. RIGGE.

The occultation of Aldebaran of next November 23-24 will be very much like that of last December 3-4 in that it will take place near midnight and with a full moon, but in this case the limit line is shifted farther south so that all the states will get to see it except Florida and portions of those bordering on the Gulf of Mexico. The annexed maps will give the circumstances.

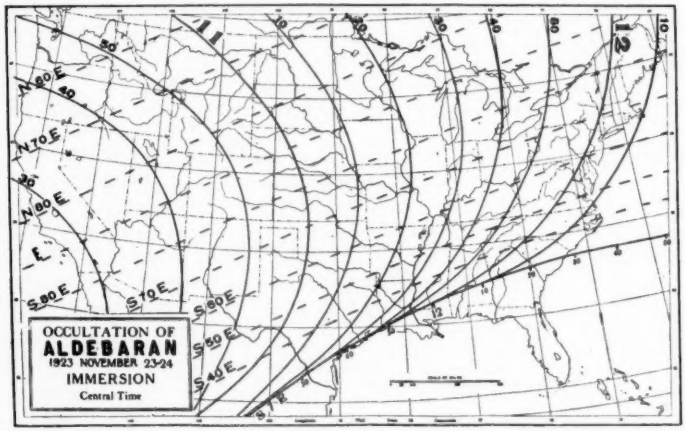


FIGURE 1.

On both maps the full lines give for every ten minutes the Central Times of the immersion, or disappearance of the star behind the moon, and of the emersion or its reappearance, the large 11, 12, 1, meaning 11 and 12 P. M. and 1 A. M. The dashed lines show the position angles

from the north and south points towards the east and west on the moon's disk, at which the star will disappear and reappear. As the moon will be 17 hours past the full, its disk will be practically all

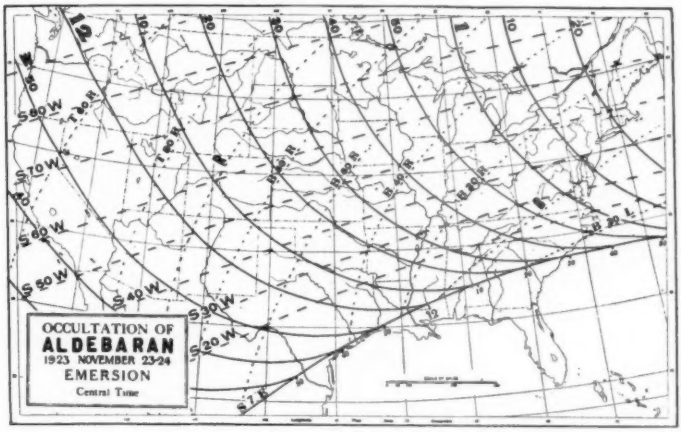


FIGURE 2.

illuminated. For the emersion the position angles are also given from the top T and bottom B of the moon towards the right R and left L. On the limit line the grazing contact will occur at S 7° E.

THE STELLAR REGION AT THE TOTAL SOLAR ECLIPSE OF 1923, SEPT. 10.

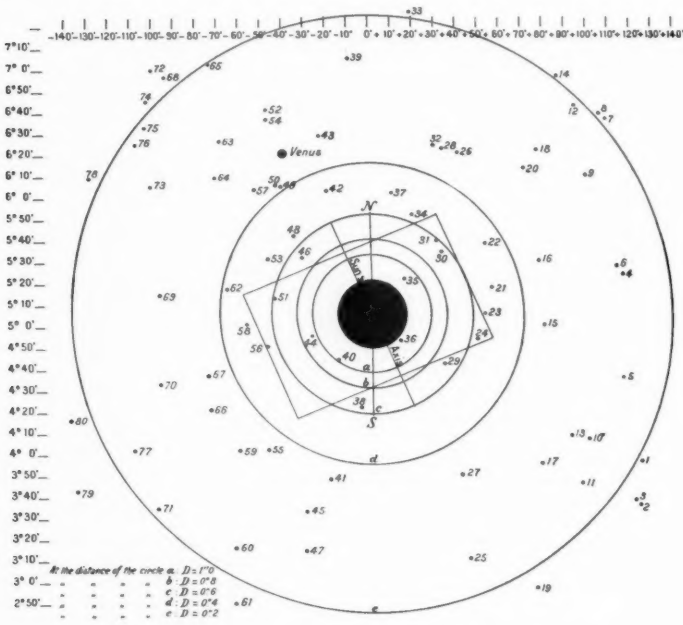
By DR. PIO EMANUELLI.

The star-field near the sun at the time of totality is shown in the accompanying diagram on which also is shown the position of the sun and the sun's axis. The rectangle around the sun's disk represents the probable extension of the solar corona in which the stars 35, 36, 40, and 44 will likely be lost.

This star-field contains 80 stars of magnitude 9.5 or brighter. This magnitude is comparatively bright for an exposure of about 3 minutes in the totality's darkness.

The gravitational deflection is 1".75 for a star at the sun's limb, (16'). The amount varies inversely as the distance from the sun: at 32'

from the sun's centre it is one-half this value, at 48′ one-third, and so on.



THE STAR-FIELD ABOUT THE SUN AT THE TOTAL ECLIPSE OF 1923 SEPTEMBER 10.

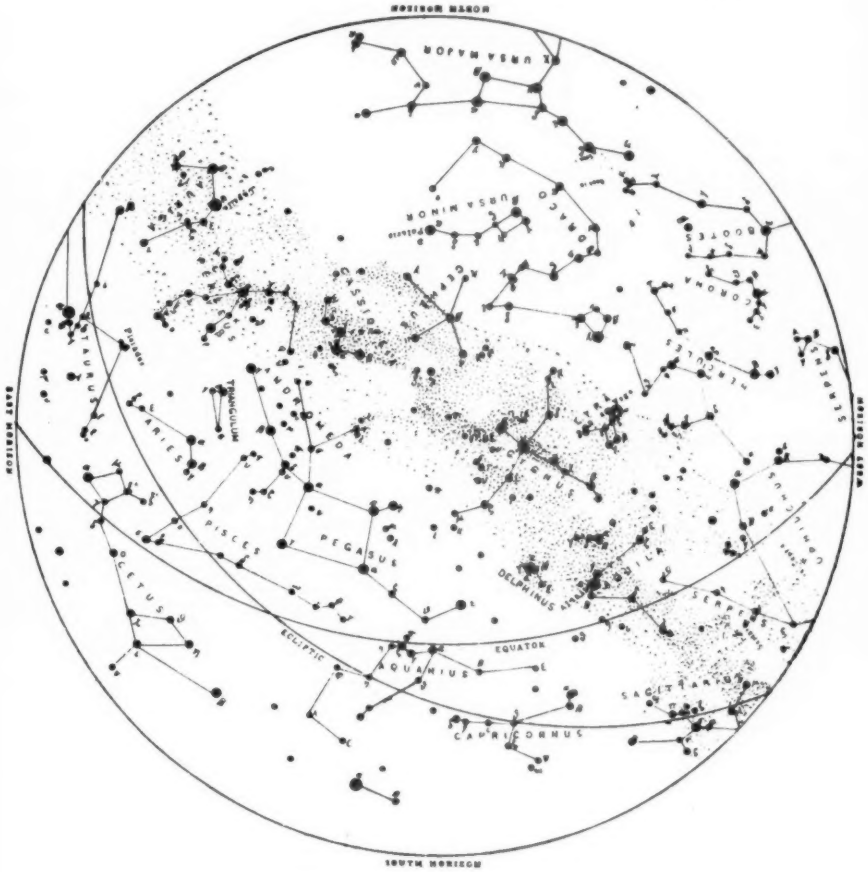
From the diagram we see that the amount of the gravitational deflection D is distributed as follows:

3	stars	with	D	>	1″.0		
1	"	"	D	between	1″.0	and	0″.8
6	"	"	D	"	0″.8	"	0″.6
12	"	"	D	"	0″.6	"	0″.4
43	"	"	D	"	0″.4	"	0″.2
15	"	"	D	<	0″.2		

Rome, 1923 June 6.

PLANET NOTES FOR NOVEMBER.

The sun will move eastward from $14^h\,23^m$ to $16^h\,22^m$, and southward from $-14°\,11'$ to $-21°\,31'$ during the month. It will pass from the constellation Libra into the constellation Scorpio. At the end of the month the sun will be very near the bright star Antares. The phases of the moon will occur as follows:



THE CONSTELLATIONS AT 9:00 P. M. NOVEMBER 1.

Last Quarter	November	1 at	3 P.M. C. S. T.
New Moon		8 "	9 A.M. "
First Quarter		15 "	4 A.M. "
Full Moon		23 "	7 A.M. "

Mercury will be invisible throughout the month. From its position of greatest western elongation on October 14, it will move eastward more rapidly than the sun, and will pass the sun on the opposite side from the earth on November 15. It will continue to swing east of the sun but not far enough to be seen before the end of the month.

Venus, after having been in the morning sky since the first of the year, will be moving eastward slightly faster than the sun. Toward the end of the month it will be seen in the southwest at sunset. It will easily be recognized because of its brightness. It will be very much brighter than Vega which will also be visible in the evening.

Mars will be slowly dropping behind the sun in their motion eastward. Consequently Mars will rise earlier from morning to morning, and by the end of the month will be fairly well up in the sky at sunrise.

Jupiter will be in conjunction with the sun on November 22. It will not be visible at any time during the month. Jupiter will be near Antares at the time of conjunction.

Saturn will be a short distance northwest of the sun during this month. It may be observed a few hours before sunrise. During the month Saturn will be very near Spica.

Uranus will be near the meridian at sunset during this month. It will therefore be visible for evening observation. It will be in the constellation Aquarius.

Neptune will be in the opposite part of the sky from Uranus, and will be on the meridian at sunrise. It will be in the constellation Leo, a short distance northwest from Regulus.

Occultations Visible at Washington.

[*From the American Ephemeris.*]

Date 1923	Star's Name	Magnitude	IMMERSION. Washington M.T.	IMMERSION. Angle from N	EMERSION. Washington M.T.	EMERSION. Angle from N	Duration
			h m	°	h m	°	h m
Nov. 2	*A* Leonis	4.6	16 14	147	17 13	248	0 59
3	*c* Leonis	5.1	15 40	147	16 32	251	0 52
16	81 Aquarii	6.4	8 47	26	9 54	279	1 7
16	Uranus	6.1	11 3	53	12 10	260	1 6
20	39 B. Arietis	6.5	7 3	81	8 22	226	1 19
20	64 Ceti	5.8	12 24	70	13 46	250	1 22
20	ξ^1 Ceti	4.5	13 47	40	14 50	285	1 3
23	70 Tauri	6.4	6 7	84	7 6	244	1 0
23	θ^1 Tauri	4.2	7 49	134	8 23	191	0 34
23	75 Tauri	5.2	7 52	30	8 44	296	0 51
23	264 B. Tauri	4.8	8 51	106	9 57	219	1 7
23	275 B. Tauri	6.5	11 14	140	11 53	189	0 38
23	α Tauri (Aldebar.)	1.1	12 50	121	13 58	217	1 8
24	115 Tauri	5.3	13 18	109	14 42	240	1 24
25	19 B. Geminorum	6.2	10 12	28	10 57	316	0 45
29	18 Leonis	5.8	12 45	121	13 52	265	1 8
29	19 Leonis	6.4	13 52	179	14 13	210	0 20
30	49 Leonis	5.7	11 13	68	11 59	319	0 46

Ephemeris of Eros (433).

(Continued from page 471.)

Gr. Midnight 1923		α h m s	δ ° ′ ″	Log r	Log Δ
Dec.	4	10 48 57	+19 26 40	0.06148	9.70697
	8	11 1 10	+16 59 8	0.05960	9.69469
	12	11 12 56	+14 25 3	0.05798	9.68278
	16	11 24 16	+11 45 16	0.05662	9.67131
	20	11 35 9	+ 9 0 8	0.05558	9.66030
	24	11 45 36	+ 6 10 30	0.05484	9.64983
	28	11 55 39	+ 3 16 57	0.05440	9.63982

VARIABLE STARS.

B. D. + 53° 3033, variable.—The variability of this star is reported in *A.N.* No. 5248, having been detected by N. P. Schanin. It was discovered from a study of plates taken at the Pulkowo observatory of the region of Nova Lacertae 1911. The variation in the brightness of this star is from $11^m.7$ to $12^m.7$ photographically. The period has not been determined. The position of the star for 1875.0 is $\alpha\ 22^h\ 50^m\ 48^s.89$, $\delta + 53°\ 33'\ 44''.7$. It is of spectral class N.

Fifteen New Variable Stars.—The following new variable stars were found by Miss Leavitt on Harvard photographs in the years 1916 to 1919. The variability has been confirmed in all cases by Miss Walker and Miss Fairfield.

Harvard Variable	DM.	R.A. 1900 h m	Dec. 1900 ° ′	Max.	Min.
3664	....	0 56.2	+37 34	10.9	11.7
3665	+26° 199	1 8.3	+26 37	10.0	10.7
3666	+23° 159	1 8.9	+23 53	9.9	10.5
3667	....	1 11.8	+38 26	9.7	10.9
3668	....	1 14.1	+30 40	11.5	12.4
3669	+21° 188	1 18.8	+21 21	10.8	12.0
3670	....	1 20.2	+20 52	11.5	[12.7
3671	+41° 376	1 50.8	+41 36	9.7	10.5
3672	+27° 433	2 40.4	+27 27	10.4	11.7
3673	−24°2096	4 2.2	−23 56	12.0	12.6
3674	....	7 51.3	+21 35	11.7	[14.0
3675	− 2°3280	10 58.5	− 2 40	10.2	11.0
3676	+37°2480	13 55.2	+37 41	9.9	10.8
3677	....	14 0.1	− 9 41	11.7	13.5
3678	−14°5604	19 53.0	−14 13	11.9	[12.5

Nos. 3664 to 3672 and 3676 were discovered in the systematic examination of Harvard Maps 11 and 17, on plates made with the 1-inch Cooke lens. Nos. 3673, 3675, and 3678 were found on plates taken with the 8-inch Bache telescope, and 3674 and 3675 on plates taken with the 16-inch Metcalf telescope. The magnitudes are based on a provisional scale.

Apparently Nos. 3671 and 3672 are eclipsing variables, and 3669 and 3670, long period variables. The period of 3668 is probably short, and 3666 appears to be a cluster type variable, according to fifty observations by Miss Leavitt. The spectrum of No. 3675 is Mc.

Harvard College Bulletin 790.

Cambridge, Massachusetts, August 1, 1923.

Minima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1923							
					November							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	6 21							
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	3 10	11 2	18 18	26 10				
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	3 15	11 3	18 14	26 2				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	6 6	12 8	24 14	30 17				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	3 6	11 20	20 10	29 0				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	2 1	8 22	22 16	29 12				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	2 3	9 7	23 15	30 19				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	3 1	11 20	20 14	29 9				
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	7 9	15 8	23 7					
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6							24 0	
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	2 14	11 4	19 18	28 9				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	2 1	8 20	22 10	29 5				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	4 10	12 8	20 5	28 3				
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	6 6	14 13	22 21					
RV Persei	4 04.2	+33 59	9.5—12.0	1 23.4	5 1	12 23	20 20	28 17				
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	3 0	16 4	29 9					
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	9 6	18 16	28 3					
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1		11 17					24 3	
TT Aurigæ	5 02 8	+39 27	7.8— 8.7	0 16.0	2 10	9 2	22 10	29 2				
RY Aurigæ	11.5	+38 13	10.7—11.7	2 17.5	1 3	9 7	17 11	25 16				
RZ Aurigæ	42.9	+31 40	10.6—13.3	3 00.3	3 9	9 10	21 11	27 11				
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	3 21	12 13	21 5	29 21				
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	9 16	20 2	30 11					
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	2 2	10 2	18 3	26 3				
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	5 23	11 16	23 3	28 20				
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	2 5	7 2	19 0	24 15				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	4 0	12 5	20 10	28 15				
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	2 20	10 11	18 2	25 17				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0		8 12		20 17				
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	6 19	13 23	21 3	28 7				
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	1 11	8 7	21 22	28 18				
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	1 20	11 3	20 10	29 18				
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	6 18	13 9	19 23	26 21				
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	5 7	15 17	22 2	30 12				
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	3 21	10 7	23 4	29 14				
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	2 6	9 13	16 19	24 2				
X Carinae	8 29.1	—58 53	7.9— 8.7	0 13.0	1 12	9 15	17 18	25 21				
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	1 16	11 4	20 16	30 3				
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 6.8	4 1	10 21	17 18	24 14				
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	1 17	7 16	19 12	25 11				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	2 11	9 5	22 16	29 10				
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	1 1	8 11	23 7	30 17				
SS Carinæ	10 54.2	—61 23	12.2—12 8	3 07.2	2 3	8 17	21 22	28 13				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	5 0	13 19	22 14					
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	4 21	12 5	19 13	26 20				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	6 1	12 20	19 15	26 10				
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	4 3	11 15	19 3	26 16				
RS Can. Ven.	13 06 3	+36 28	7.5—12.5	4 19.1	8 21	18 12	28 2					
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	8 10	15 20	23 6	30 17				
133926 Hydræ	13 39.0	—26 23	8.6—12.7	2 21.5	2 1	8 15	20 5	26 0				

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1923							
					November							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	1 2	8 1	22 1	29 0				
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	4 8	11 6	18 4	25 1				
TW Draconis	15 32.4	+64 14	7.3— 8.9	2 19.3	1 5	9 16	18 2	26 12				
SS Librae	15 43.4	—15 14	9.3—11.5	0 18.4	7 5	14 10	21 15	28 19				
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	1 14	8 22	23 14	30 23				
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	2 18	11 1	19 6	27 13				
R Aræ	31.1	—56 48	6.8— 7.9	4 10.2	1 1	9 21	18 17	27 14				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1		12 5						
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	2 4	8 23	22 14	29 9				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	7 9	15 18	24 3					
μ Herculis	13.6	+33 12	4.6— 5.4	2 01.2	5 7	11 11	23 18	29 22				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	5 5	11 19	24 4	30 8				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	7 22	15 7	22 16	30 1				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	8 2	16 6	24 10					
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	2 19	10 8	17 21	25 10				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	7 13	15 7	23 1	30 19				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	3 3	11 3	19 3	27 2				
WX Sagittarii	53.6	—17 24	9.2—10.8	2 03.1	4 18	13 6	21 18	30 7				
WY Sagittarii	17 54.9	—23 1	9.5—10.6	4 16.0	7 20	17 5	26 13					
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	9 20	20 4	30 12					
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	7 17	14 23	22 4	29 11				
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	2 19	9 17	23 13	30 10				
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2	1 1		16 4					
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	3 23	11 3	18 7	25 23				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	3 23	11 2	18 5	25 7				
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	6 13	14 21	23 4					
RR Draconis	40.8	+62 34	9.3—13	2 19.9	3 22	12 9	20 21	29 9				
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	4 20	11 12	18 3	24 18				
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8		11 10	24 8					
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	4 19	12 11	20 2	27 18				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	6 23	14 13	22 3	29 16				
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	3 6	10 11	17 16	24 21				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	3 16	12 15	21 14	30 13				
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	1 23	8 17	22 6	30 0				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	1 9	8 18	23 12	30 20				
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	4 19	10 1	20 12	25 18				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	5 4	11 17	18 5	24 18				
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	1 1	7 1	19 2	25 2				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	2 5	8 20	22 3	28 18				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	2 23	12 2	21 6	30 9				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	1 4	9 14	18 1	26 11				
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	3 16	10 11	24 1	30 19				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	3 11	10 9	17 6	24 4				
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0		18 16						
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	5 10	15 1	24 15					
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	1 20	11 1	20 6	29 11				
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	3 21	12 21	21 20	30 20				
WZ Cygni	48.3	+38 27	9.9—10.8	0 14.0	6 23	14 14	22 4	29 18				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	3 15	13 17	23 20					
RY Aquarii	14.8	—11 14	8.8—10.4	1 23.2	5 17	13 13	21 10	29 7				
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	2 1	12 4	22 8					
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	2 12							
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	4 5	14 14	19 18	30 3				
VW Pegasi	51.7	+32 41	10.0—10.6	5 06.4	2 4	7 10	17 23	28 12				
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.3	5 6	12 19	20 8	27 20				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	5 3	13 9	21 14	29 20				

Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1923 November							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7	2 14							
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	9 13	17 6	25 10					
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	1 4	8 22	16 15	24 9				
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2		13 8		28 3				
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	3 18	11 17	19 15	27 14				
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	8 3	15 23	23 18					
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 10.0	5 7		21 17					
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	7 11	16 1	24 15					
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	4 23	16 2	27 5					
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	9 9		21 1					
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	4 2	11 18	19 10	27 2				
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3	9 6	19 9	29 12					
Y Aurigæ	21.5	+42 21	8.6— 9.6	3 20.6	2 2	9 19	17 12	25 6				
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	2 15	13 16	19 5	30 7				
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	6 2	13 4	21 6	28 19				
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3		9 10						
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	3 9	10 20	18 7	25 18				
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	7 8	15 5	23 4					
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	2 14	12 18	22 22					
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5			20 6					
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	4 4	12 2	20 1	28 0				
V Carinæ	8 26.7	—59 47	7.4— 8.1	6 16.7	6 10	13 3	19 19	26 12				
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	1 22	11 4	20 11	29 18				
V Velorum	9 19.2	—55 32	7.5— 8.2	4 08.9	4 11	13 5	21 23	30 16				
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 00.0				28 9				
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	3 11	10 6	23 20	30 14				
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	6 8	12 22	19 13	26 3				
S Muscae	12 07.4	—69 36	6.4— 7.3	9 15.8	6 3	15 19	25 11					
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	1 2	9 1	17 1	26 0				
T Crucis	15.9	—61 44	6.8— 7.6	6 17.6	2 8	9 1	22 12	29 12				
R Crucis	18.1	—61 04	6.8— 7.9	5 19.8	5 17	11 13	23 5	29 1				
S Crucis	12 48.4	—57 53	6.5— 7.6	4 16.6	2 16	7 8	16 18	26 3				
W Virginis	13 20.9	— 2 52	8.7—10.4	17 06.5	3 5		20 11					
SS Hydræ	25.0	—23 08	7.4— 8.1	8 04.8	1 15	9 20	18 0	26 5				
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	6 21	13 22	20 22	27 23				
ST Virginis	14 22.5	— 0 27	10.3—11.4	0 09.9	8 19	17 0	25 5					
V Centauri	25.4	—56 27	6.4— 7.8	5 11.9	3 22	9 10	20 10	25 22				
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	6 8	13 21	21 11	28 23				
R Triang.Austr.	15 10.8	—66 08	6.7— 7.4	3 09.3	1 8	8 3	21 17	28 11				
S Triang.Austr.	15 52.2	—63 29	6.4— 7.4	6 07.8	6 8	12 16	18 23	25 6				
S Normæ	16 10.6	—57 39	6.6— 7.6	9 18.1	4 16	14 10	24 4					
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	8 11	17 7	26 4					
RV Scorpii	16 51.8	—33 27	6.7— 7.4	6 01.5	1 7	7 9	19 12	25 13				
X Sagittarii	17 41.3	—27 48	4.4— 5.0	7 00.3	4 15	11 15	18 16	25 16				
Y Ophiuchi	47.3	— 6 07	6.1— 6.5	17 02.9	2 5		19 8					
W Sagittarii	17 58.6	—29 35	4.3— 5.1	7 14.3	3 1	10 14	18 5	25 19				
Y Sagittarii	18 15.5	—18 54	5.4— 6.2	5 18.6	2 5	8 0	19 13	25 7				
U Sagittarii	26.0	—19 12	6.5— 7.3	6 17.9	6 8	13 2	19 20	26 14				
Y Scuti	32.6	— 8 27	8.7— 9.2	10 08.3	1 17	12 1	22 10					
RZ Lyræ	18 39.9	+32 42	9.9—11.2	0 12.3	2 14	8 17	21 0	27 3				
RT Scuti	18 44.1	—10 30	9.1— 9.7	0 11.9	6 7	12 6	24 3	30 2				
κ Pavonis	18 46.6	—67 22	3.8— 5.2	9 02.2	6 4	15 6	24 8					
U Aquilæ	19 24.0	— 7 15	6.2— 6.9	7 00.6	2 9	9 10	23 11	30 12				

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1923 November					
	h m	° ′		d h	d h	d h	d h	d h	d h	d h
XZ Cygni	19 30.4	+56 10	8.6— 9.3	0 11.2	4 20	11 20	18 20	25 20		
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	4 10	12 9	20 9	28 8		
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	8 6	15 23	23 15			
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	1 22	9 2	23 11	30 15		
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	2 12	10 22	19 7	27 16		
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	2 5	8 12	21 4	27 11		
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	1 1		17 10			
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	3 20	8 6	17 3	26 0		
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	1 16	8 9	21 20	28 14		
RV Capric.	55.9	—15 37	9.2—10.1	0 10.7	1 16	8 9	21 19	28 12		
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	8 23		22 17			
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	4 5	11 2	18 23	26 19		
SW Aquarii	10.2	— 0 20	9.9—10.8	0 11.0	1 20	8 18	22 13	29 10		
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	1 11	11 4	20 22	30 15		
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	7 21	16 13	25 4			
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	3 17	14 11	19 19	30 13		
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1	1 0	11 21	22 19			
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	6 8	12 18	19 4	25 14		
V Lacertæ	44.5	+55 48	8.5— 9.5	4 23.6	4 4	14 3	19 3	29 2		
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	1 0	11 21	17 8	28 5		
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	3 22	9 9	20 6	25 16		
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	6 5	12 12	18 20	25 3		
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	1 18	13 21	26 0			
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	6 15	13 14	20 14	27 13		

Monthly Report of the American Association of Variable Star Observers, June 20 to August 20, 1923.

There are many points of interest in the present report such as the rapid rise of Chi Cygni, 194632, and the maximum of SS Aurigae on July 24, well observed by Messrs. Lacchini and Waterfield.

Messrs. Olcott and Yalden spent a part of August at Dr. Godfrey's camp in Maine where Mr. Chandler of Belgrade Lakes visited them. Mr. Chandler has recently acquired a 10-inch reflector and plans to erect it in a dome devised by Mr. Yalden. The 4-inch McCormick telescope so faithfully used by Mr. Suter during the past few years has been loaned to Mr. Cunningham of Wiscasset, Me. Mr. Suter will have the use of the 6-inch glass of the Charles Alfred Post Memorial while he is attending Harvard College.

Rev. T. C. H. Bouton, of St. Petersburg, Fla., is to enlarge his 6-inch equipment by the purchase of a 7-inch McDowell lens. M. G. B. Lacchini, of Faenza, Italy, has accepted the loan of the 6-inch telescope formerly used by Signor Tacchini. Mr. Wm. D. MacPherson, of Framingham, Mass., has been elected a patron of the Association. Mr. MacPherson has presented his entire astronomical equipment to the Association.

A revised membership list has been distributed to members. Besides those mentioned in the Supplementary List, dated July 25, 1923, the following have been recently elected to Annual Membership:

Nicholas Iedema, Great Neck, N. Y.

Eugene Janssens, Melbourne, Australia.

N. W. Storer, Middletown, Ct.

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923.

June 0 = J. D. 2423571. July 0 = J. D. 2423601. August 0 = J. D. 2423632

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
000330 V SCULPTORIS—				
	3563.3	13.5 Bl.		
001032 S SCULPTORIS—				
	3355.9	12.7 Kd.	3424.0	7.6 Kd.
	3391.9	7.3 Kd.	3425.9	7.7 Kd.
	3393.9	7.2 Kd.	3431.9	7.9 Kd.
	3400.9	7.0 Kd.	3563.3	12.7 Bl.
	3405.9	7.2 Kd.	3596.2	12.8 Bl.
	3412.9	7.3 Kd.		
001046 X ANDROMEDAE—				
	3606.8	13.7 Wf.	3638.8	13.8 Wf.
	3619.8	14.0 Wf.	3650.8	12.3 M.
001620 T CETI—				
	3610.2	6.1 Kd.	3618.6	5.4 L.
	3611.6	5.4 L.	3624.2	5.8 Kd.
001726 T ANDROMEDAE—				
	3609.3	9.1 Ch.	3640.8	12.6 M.
	3610.8	9.5 M.	3641.8	11.4 Pt.
	3613.8	9.7 Pt.	3643.8	11.0 Br.
001755 T CASSIOPEIAE—				
	3577.6	8.3 L.	3613.8	8.0 L.
	3584.5	8.7 Gi.	3616.4	8.5 L.
	3593.6	8.4 L.	3616.8	7.2 M.
	3601.5	8.7 Gi.	3626.8	8.6 Br.
	3610.8	9.0 M.	3641.8	8.1 Pt.
001838 R ANDROMEDAE—				
	3606.8	11.2 Wf.	3622.9	13.0 Br.
	3614.8	11.8 Pt.	3638.8	13.7 Wf.
	3619.8	12.5 Wf.	3614.8	13.0 Pt.
001862 S TUCANAE—				
	3596.2	8.9 Bl.		
002546 T PHOENICIS—				
	3596.3	11.6 Bl.		
002833 W SCULPTORIS—				
	3563.3	13.0 Bl.	3596.2	13.0 Bl.
004047 U CASSIOPEIAE—				
	3606.8	10.5 Wf.	3627.8	11.4 Br.
	3609.8	10.3 M.	3631.8	12.1 Wf.
	3614.8	10.8 Pt.	3641.8	12.3 Pt.
	3619.8	11.2 Wf.		
004132a RW ANDROMEDAE—				
	3609.8	[13.8 Wf.	3644.7	12.7 Pt.
	3637.8	[13.1 Wf.		
004435 V ANDROMEDAE—				
	3643.8	10.2 Br.		
004435 X SCULPTORIS—				
	3563.3	13.4 Bl.		
004533 RR ANDROMEDAE—				
	3609.8	[13.9 Wf.	3619.8	[14.1 Wf.
004746a RV CASSIOPEIAE—				
	3609.8	[14.0 Wf.	3619.6	15.5 L.
004958 W CASSIOPEIAE—				
	3601.6	9.2 Gi.	3627.8	10.2 Br.
	3610.8	10.5 M.	3644.7	11.1 Pt.
	3614.8	10.2 Pt.		
005475 U TUCANAE—				
	3540.9	8.5 Bl.	3579.0	9.3 Bl.
	3554.9	8.4 Bl.	3596.3	10.1 Bl.
	3565.9	8.6 Bl.		
010102 Z CETI—				
	3614.8	13.6 Pt.	3644.7	12.8 Pt.
010940 U ANDROMEDAE—				
	3609.7	12.0 M.	3619.8	12.0 Wf.
	3609.8	12.0 Wf.	3637.8	12.7 Wf.
011041 UZ ANDROMEDAE—				
	3609.8	14.6 Wf.	3637.8	[14.2 Wf.
	3619.8	14.4		
011272 S CASSIOPEIAE—				
	3610.8	8.5 M.	3637.8	7.7 Wf.
	3614.8	7.6 Pt.	3638.7	7.5 Br.
	3619.8	7.9 Wf.	3644.7	7.5 Pt.
	3623.7	7.6 M.		
011712 U PISCIUM—				
	3599.8	8.5 Wf.	3644.7	11.5 Pt.
	3609.8	8.0 Wf.	3647.8	10.3 M.
012502 R PISCIUM—				
	3614.8	10.7 Pt.	3644.8	11.5 Pt.
013238 RU ANDROMEDAE—				
	3609.8	10.2 Wf.	3629.9	7.0 Br.
	3614.8	10.6 Pt.	3637.8	10.8 Wf.
	3615.3	10.0 Ch.	3644.8	11.8 Pt.
	3619.8	10.4 Wf.	3645.8	11.8 M.
013338 Y ANDROMEDAE—				
	3609.8	12.2 Wf.	3637.8	9.7 Wf.
	3614.8	11.9 Pt.	3644.8	9.1 Pt.
	3619.8	11.4 Wf.	3645.8	9.5 M.
	3629.9	10.1 Br.		
014958 X CASSIOPEIAE—				
	3610.8	11.0 M.	3644.8	10.0 Pt.
	3614.8	9.6 Pt.	3650.8	10.5 M.
015354 U PERSEI—				
	3610.8	10.2 M.	3645.8	9.7 M.
	3624.8	9.9 Pt.	3500.0	9.0 Jk.
	3644.8	9.6 Pt.		
015912 S ARIETIS—				
	3614.8	12.5 Pt.	3644.8	13.8 Pt.
021024 R ARIETIS—				
	3605.6	10.0 L.	3618.8	10.5 M.
	3609.8	10.4 Wf.	3620.8	11.3 Wf.
	3610.6	10.0 Gi.	3637.8	12.7 Wf.
	3612.8	10.7 Ca.	3640.8	12.6 M.
	3614.8	11.1 Pt.	3644.8	12.7 Pt.
	3618.6	10.6 L.		
021143a W ANDROMEDAE—				
	3609.8	12.5 Wf.	3620.8	12.4 Wf.
	3612.6	12.3 Gi.	3637.8	11.4 Wf.
	3614.8	12.1 Pt.	3644.8	11.9 Pt.
021558 T PERSEI—				
	3485.0	9.5 Jk.	3644.8	8.2 Pt.
	3614.8	8.5 Pt.		
021281 Z CEPHEI—				
	3620.8	14.5 Wf.		
021403 o CETI—				
	3487.6	2.9 Jb.	3614.8	6.5 Pt.
	3487.6	2.7 Jb.	3625.6	7.5 L.
	3610.2	7.1 Kd.	3644.8	7.8 Pt.
	3611.6	7.1 L.		

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
021558 S PERSEI—						
	3485.0	10.8	Jk,	3614.8	10.1	Pt,
	3500.0	10.7	Jk,	3644.8	9.7	Pt.
022150 RR PERSEI—						
	3609.8	12.8	Wf,	3638.8	13.7	Wf,
	3614.8	12.6	Pt,	3645.8	13.8	Pt.
	3620.8	12.5	Wf,			
022426 R FORNACIS—						
	3563.3	9.8	Bl,	3596.3	9.3	Bl.
022813 U CETI—						
	3645.8	8.4	Pt.			
022980 RR CEPHEI—						
	3573.4	13.4	L,	3620.8	10.7	Wf,
	3593.6	12.7	L,	3627.8	10.7	Br,
	3609.8	11.9	Wf,	3630.6	10.7	L,
	3614.8	10.8	Pt,	3638.8	8.4	Wf,
	3616.4	14.2	L,	3644.8	10.4	Pt.
023133 R TRIANGULI—						
	3610.8	6.3	M,	3640.8	7.0	M,
	3614.8	6.4	Pt,	3645.8	7.0	Pt.
	3629.9	7.0	Br,			
024356 W PERSEI—						
	3610.8	9.3	M,	3640.8	9.0	M,
	3611.7	9.1	Ca,	3645.8	9.0	Pt.
	3614.8	8.9	Pt,			
025050 R HORAE—						
	3554.9	12.5	Bl,	3596.3	11.2	Bl.
	3565.9	12.4	Bl.			
025751 T HORAE—						
	3540.9	11.0	Bl,	3596.3	13.3	Bl.
	3554.9	12.1	Bl,			
030514 U ARIETIS—						
	3611.6	9.7	Gi.			
031401 X CETI—						
	3611.6	9.7	L,	3625.6	9.4	L,
	3614.8	9.5	Pt,	3645.8	8.8	Pt.
032043 Y PERSEI—						
	3614.8	10.2	Pt,	3640.8	9.7	M,
	3614.8	10.3	M,	3645.8	9.6	Pt.
032335 R PERSEI—						
	3610.6	13.6	Gi,	3638.8	14.8	Wf,
	3620.8	14.0	Wf,	3645.8	14.4	Pt.
041619 T TAURI—						
	3650.9	9.7	M.			
042209 R TAURI—						
	3645.8	11.0	Pt,	3650.9	10.0	M.
042215 W TAURI—						
	3605.9	11.5	M,	3645.8	11.1	Pt.
042309 S TAURI—						
	3645.8	12.3	Pt.			
043065 T CAMELOPARDALIS—						
	3573.4	8.7	L,	3616.4	8.5	L,
	3581.6	8.5	L,	3645.8	8.8	Pt,
	3593.4	8.2	L,	3650.8	9.7	M.
	3614.8	7.8	Pt,			
043208 RX TAURI—						
	3645.8	12.7	Pt.			
043263 R RETICULAE—						
	3540.9	11.3	Bl,	3578.9	8.5	Bl,
	3554.9	10.4	Bl,	3596.3	8.3	Bl.
	3565.9	9.8	Bl,			
043274 X CAMELOPARDALIS—						
	3485.0	10.0	Jk,	3619.6	10.4	O,
	3585.7	12.4	Wf,	3602.8	10.2	Wf,
	3609.6	10.9	O,	3638.8	8.6	Wf,
	3609.9	11.2	Wf,	3642.7	8.0	Br,
	3614.8	10.5	Pt,	3645.8	7.6	Pt.
043562 R DORADUS—						
	3540.9	5.5	Bl,	3578.9	5.0	Bl.
043738 R CAELI—						
	3540.9	9.3	Bl,	3585.9	10.4	Bl,
	3554.9	9.8	Bl,	3596.3	11.4	Bl.
	3565.9	10.1	Bl,			
050003 V ORIONIS—						
	3645.8	10.1	Pt.			
050032 T LEPORIS—						
	3540.9	10.4	Bl,	3565.9	11.8	Bl.
	3556.9	12.2	Bl,			
050818 S PICTORIS—						
	3554.9	13.0	Bl.			
050953 R AURIGAE—						
	3585.9	12.9	Wf,	3638.8	13.3	Wf,
	3614.8	13.2	Pt,	3645.8	13.5	Pt.
	3620.8	13.4	Wf,			
051247 T PICTORIS—						
	3554.9	12.6	Bl,	3585.9	11.2	Bl,
	3565.9	11.5	Bl,	3595.9	9.9	Bl.
	3578.9	11.1	Bl,			
051533 T COLUMBAE—						
	3540.9	11.9	Bl,	3585.9	11.9	Bl,
	3554.9	12.6	Bl,	3596.3	10.3	Bl.
052034 S AURIGAE—						
	3614.8	8.8	Pt,	3650.8	9.7	M.
	3645.8	8.5	Pt.			
052036 W AURIGAE—						
	3645.8	13.2	Pt.			
052404 S ORIONIS—						
	3645.9	11.6	Pt,	3650.9	10.7	M.
053005a T ORIONIS—						
	3515.3	10.2	An,	3645.9	10.7	Pt.
053068 S CAMELOPARDALIS—						
	3614.8	8.6	Pt,	3645.8	8.5	Pt.
053531 U AURIGAE—						
	3645.9	9.5	Pt.			
054319 SU TAURI—						
	3484.9	9.6	Jk,	3645.9	9.4	Pt.
	3650.9	9.5	M,			
054331 S COLUMBAE—						
	3540.9	12.6	Bl,	3565.9	11.7	Bl,
	3554.9	12.4	Bl,	3585.9	9.9	Bl.
054920a U ORIONIS—						
	3645.8	6.3	Pt,	3650.9	6.8	M.
054945 TW AURIGAE—						
	3430.1	8.8	Kd,	3431.9	8.7	Kl.

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
054974 V CAMELOPARDALIS—						
	3585.7	13.1	Wf,	3620.8	13.2	Wf,
	3605.9	13.2	Wf,	3638.8	13.5	Wf.
	3610.4	13.2	Gi,			
055353 Z AURIGAE—						
	3585.7	9.8	Wf,	3602.8	10.6	Wf,
	3599.7	9.7	Wf,	3638.8	10.8	Wf,
	3609.7	9.7	Wf,	3645.8	10.2	Pt,
	3618.8	10.8	Pt,	3650.9	10.8	M.
055686 R OCTANTIS—						
	3592.0	12.0	Bl.			
060450 X AURIGAE—						
	3618.8	8.8	Pt,	3645.8	10.2	Pt.
060547 SS AURIGAE—						
	3541.2	[11.2	Ch,	3602.8	[13.3	Wf,
	3550.1	[11.0	Ch,	3621.6	[12.9	Gi,
	3585.7	[13.0	Wf,	3621.7	[12.4	Wf,
	3604.7	[12.4	Wf,	3622.5	[12.4	L,
	3609.8	[12.4	Wf,	3622.8	[13.9	Wf,
	3610.6	[11.1	Gi,	3625.6	11.0	L,
	3610.8	[11.0	Pt,	3626.8	11.0	Wf,
	3611.6	[12 0	L,	3627.8	11.3	Wf,
	3611.8	[12.3	Wf,	3628.8	11.6	Wf,
	3612.6	[12.4	Gi,	3630.6	12.2	L,
	3612.8	[12.4	Wf,	3633.8	[12.4	Wf,
	3613.6	[12.4	Gi,	3634.8	[12.4	Wf,
	3614.8	[12.6	Pt,	3637.8	[12.4	Wf.
	3614.9	[13.3	Wf,	3638.8	[13.7	Wf,
	3615.6	[12.4	Gi,	3639.8	[13.9	Wf,
	3616.8	[13.0	Wf,	3641.8	[12.4	Pt,
	3618.6	[12.4	L.	3642.8	[13.9	Wf,
	3618.8	[12.4	Pt,	3644.8	[12.4	Pt,
	3619.6	[12.4	Gi,	3645.6	[12.6	Pt,
	3619.6	[12.4	L.	3650.1	[12.4	Pt,
	3620.5	[12.4	L,	3651.7	[12.4	Pt.
063558 S LYNCIS—						
	3618.8	11.5	Pt.	3645.8	12.8	Pt.
065355 R LYNCIS—						
	3599 7	7.4	Wf.	3602.8	8.4	Wf,
	3607.6	7.4	Gi.	3638.8	8.4	Wf,
	3609.7	7.7	Wf.	3645.8	8.7	Pt.
	3618.8	8.0	Pt.			
073173 S VOLANTIS—						
	3555.0	13.3	Bl.			
074241 W PUPPIS—						
	3540.9	9.	Bl,	3578.9	12.1	Bl.
	3555.0	10 8	Bl,	3595.9	11.0	Bl.
	3565.9	12.1	Bl.			
074922 U GEMINORUM—						
	3542.1	[12.4	Ch,	3557.1	[12.4	Ch,
	3543.1	[11.8	Ch,	3559.1	[10.9	Ch,
	3547.1	[10.9	Ch,	3561.1	[10.9	Ch,
	3548.1	[10.9	Ch,	3562.1	[10.9	Ch.
	3549.1	[10.9	Ch.	3571.1	[10.9	Ch,
	3550.1	[11.4	Ch,	3572.1	[10.9	Ch,
	3551.1	[11.4	Ch,	3573.1	[10.9	Ch,
	3553.1	[11.4	Ch.	3573.4	[10.9	L,
	3555.1	[11.4	Ch.	3575.1	[10.9	Ch.
081112 R CANCRI—						
	3548.1	8.3	Ch,	3571.1	8.7	Ch.
	3550.5	8.3	Fe,			
082476 R CHAMELEONTIS—						
	3555.0	12.5	Bl,	3592.0	10.7	Bl,
	3565.9	12.4	Bl.	3598.9	9.6	Bl.
	3578.9	12.1	Bl.			
085120 T CANCRI—						
	3582.4	9.3	L.			
090151 V URSAE MAJORIS—						
	3565.1	11.0	Nk,	3581.4	10.8	Pe,
091868 RW CARINAE—						
	3592.0	12.4	Bl,	3598.9	12.0	Bl.
092551 Y VELAE—						
	3540.9	9.8	Bl,	3578.9	10.5	Bl,
	3555.0	10.0	Bl,	3592.0	11.6	Bl.
	3565.9	10.9	Bl.			
092662 R CARINAE—						
	3540.9	6.1	Bl,	3578.9	7.8	Bl,
	3555.0	6.7	Bl,	3592.0	7.9	Bl,
	3565.9	7.0	Bl,	3598.9	8.4	Bl.
093014 X HYDRAE—						
	3552.1	10.7	Ch,	3573.1	10.1	Ch.
093178 Y DRACONIS—						
	3629.8	8.6	Br.			
093934 R LEONIS MINORIS—						
	3552.2	8.6	Ch,	3609.1	9.9	Ch,
	3682.4	9.4	L,	3610.4	10.0	L,
	3605.6	10.5	Pt,			
094211 R LEONIS—						
	3515.3	9.9	An,	3594.0	8.1	Kd,
	3552.2	8.6	Ch,	3594.7	7.1	Sg,
	3565.0	7.9	Nk,	3605.6	6.3	Pt,
	3575.2	8.4	Ch,	3609.1	6.8	Ch.
	3577.0	8.5	Kd.			
094953 Z VELAE—						
	3592.0	13.3	Bl.			
095421 V LEONIS—						
	3602.7	9.6	Wf,	3605.6	9.6	Pt.
095563 RV CARINAE—						
	3540.9	12.0	Bl,	3592.0	13.1	Bl.
	3555.0	12.3	Bl,			
100661 S CARINAE—						
	3540.9	5 5	Bl,	3578.9	5.2	Bl,
	3555.0	5.5	Bl,	3592.0	5.5	Bl,
	3565.9	5.5	Bl,	3598.9	5.7	Bl.
101153 W VELAE—						
	3555.0	13.3	Bl,	3598.9	11.2	Bl.
	3592.1	11.1	Bl,			
103212 U HYDRAE—						
	3569.0	5.4	Kd,	3594.0	5.3	Kd.
	3577.0	5.5	Kd,			
103769 R URSAE MAJORIS—						
	3548.1	8.4	Ch,	3611.7	8.4	Ca,
	3533.6	8.8	Fe,	3613.7	8.3	Kl,
	3537.7	8.8	Fe,	3616.6	8.6	Lv,
	3550.6	7.3	Fe,	3616.7	9.4	Wf,
	3552.0	8.2	Jk,	3617.1	8.6	Ch,
	3557.1	7.7	Ch,	3617.5	6.4	Fe,

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
103769 R URSAE MAJORIS—Continued						
	3563.6	7.4	Fe,	3618.7	8.6	Cd,
	3572.1	7.6	Ch,	3618.7	8.1	Kl,
	3578.6	7.3	Fe,	3618.7	8.7	Sg,
	3589.5	8.0	Ro,	3619.6	8.6	O,
	3590.5	8.2	Ro,	3620.6	8.4	Kl,
	3594.7	8.2	Sg,	3623.8	9.4	Wf,
	3596.6	8.2	Gd,	3625.6	10.2	M,
	3599.7	8.4	Wf,	3626.7	8.4	Kl,
	3600.5	8.2	Ro,	3631.7	9.6	Kl,
	3604.5	8.2	Ro,	3632.6	9.3	Pt,
	3605.6	8.7	Pt,	3634.6	9.1	Fe,
	3606.8	8.2	Sg,	3637.7	9.8	Sg,
	3607.6	8.3	Kl,	3638.7	9.9	Wf,
	3609.6	8.3	M,	3640.6	10.1	Ly,
	3609.6	8.2	O,	3643.6	9.2	Fe,
	3609.6	8.4	Lv,	3647.6	10.5	Ly,
	3609.7	8.8	Wf,			
104620 V HYDRAE—						
	3540.9	8.7	Bl,	3573.1	9.3	Ch,
	3552.1	9.5	Ch,	3579.0	9.0	Bl,
	3555.0	9.5	Bl,	3595.9	8.9	Bl,
	3565.9	8.5	Bl,			
104638 RS HYDRAE—						
	3555.0	13.5	Bl,	3595.9	12.3	Bl,
111561 RY CARINAE—						
	3579.0	14.0	Bl,	3598.9	12.3	Bl,
	3592.1	12.5	Bl,			
111661 RS CENTAURI—						
	3579.0	9.2	Bl,	3598.9	11.2	Bl,
	3592.1	10.5	Bl,			
114441 X CENTAURI—						
	3555.0	12.8	Bl,			
115058 W CENTAURI—						
	3555.0	13.0	Bl,	3598.9	11.6	Bl,
	3592.1	11.9	Bl,			
115919 R COMAE—						
	3599.7	9.0	Wf,	3609.7	9.3	Wf,
	3605.6	9.1	Pt,	3609.7	9.3	Wf,
	3608.6	9.6	Ya,	3612.7	9.3	Lv,
	3609.2	9.6	Ch,	3616.7	9.4	Wf,
120012 SU VIRGINIS—						
	3605.6	12.5	Pt,			
120095 T VIRGINIS—						
	3605.6	10.1	Pt,			
121418 R CORVI—						
	3577.0	12.7	Kd,	3582.4	11.3	L,
122001 SS VIRGINIS—						
	3582.4	8.7	L,	3602.3	8.7	L,
	3594.0	9.2	Kd,	3613.4	8.6	L,
122532 T CANUM VENATICORUM—						
	3605.6	9.1	Pt,	3609.6	9.8	M,
	3608.6	9.5	Ya,	3632.6	9.6	Pt,
122803 Y VIRGINIS—						
	3582.4	11.3	L,			
122854 U CENTAURI—						
	3592.1	10.5	Bl,	3598.9	10.9	Bl,

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
123160 T URSAE MAJORIS—						
	3557.6	8.7	Fe,	3616.7	9.3	Wf,
	3571.2	8.6	Ch,	3617.6	9.4	Fe,
	3571.6	8.6	Fe,	3617.6	9.5	Ly,
	3589.5	8.9	Ro,	3617.7	9.4	Sg,
	3594.7	9.0	Sg,	3618.7	9.4	Kl,
	3596.6	8.9	Gd,	3619.6	10.1	O,
	3599.7	9.1	Lv,	3620.6	9.4	Kl,
	3600.5	8.7	Ro,	3620.6	9.8	Ly,
	3601.5	8.8	Ro,	3623.8	9.5	Wf,
	3604.5	8.9	Ro,	3630.6	10.1	Ly,
	3605.6	9.4	Pt,	3632.6	10.1	Pt,
	3606.8	9.0	Sg,	3633.6	10.4	Ly,
	3608.6	9.2	Ya,	3634.6	10.0	Fe,
	3609.6	9.2	O,	3637.7	10.0	Sg,
	3609.7	9.2	Kl,	3638.7	10.1	Wf,
	3611.7	9.6	Ca,	3640.6	11.0	Ly,
	3613.7	9.4	Lv,	3643.5	11.4	Ro,
	3613.7	9.2	Kl,	3643.6	10.4	Fe,
	3614.7	9.4	Ly,	3646.5	11.6	Ro,
	3616.5	9.2	Ro,	3646.6	10.9	Ft,
123307 R VIRGINIS—						
	3573.4	11.2	Pe,	3608.6	9.7	Ya,
	3576.4	10.2	Pe,	3610.4	9.6	L,
	3584.4	10.8	L,	3627.4	8.1	L,
	3605.6	10.0	Pt,	3640.6	7.0	Pt,
	3607.6	9.5	Ca,			
123459 RS URSAE MAJORIS—						
	3604.7	14.4	Wf,	3623.8	14.2	Wf,
	3605.6	14.6	Pt,	3638.7	13.6	Wf,
	3611.8	14.2	Wf,	3644.7	13.6	Pt,
	3616.7	14.2	Wf,			
123961 S URSAE MAJORIS—						
	3515.3	9.4	An,	3614.7	8.6	Ly,
	3571.2	7.8	Ch,	3616.4	8.2	L,
	3573.4	7.7	L,	3616.5	8.4	Ro,
	3589.5	7.5	Ro,	3616.7	8.8	Wf,
	3594.7	7.2	Sg,	3617.7	8.4	Sg,
	3595.3	8.0	An,	3617.6	8.6	Ly,
	3595.4	8.0	L,	3619.6	8.3	O,
	3596.6	7.8	Gd,	3620.6	8.5	Ly,
	3599.7	8.1	Ly,	3622.4	8.7	An,
	3599.8	8.0	Wf,	3622.7	8.5	Lv,
	3600.5	7.5	Ro,	3623.8	8.8	Wf,
	3601.5	7.5	Ro,	3626.4	8.6	L,
	3604.5	8.0	Ro,	3630.6	8.8	Ly,
	3605.6	8.0	Pt,	3632.6	8.7	Pt,
	3606.8	7.3	Sg,	3633.6	8.9	Ly,
	3607.7	8.2	Lv,	3637.7	9.0	Sg,
	3608.6	8.5	Ya,	3638.7	9.0	Wf,
	3609.6	8.3	M,	3640.6	8.9	Ly,
	3609.6	8.3	O,	3643.5	9.1	Ro,
	3609.7	8.6	Wf,	3646.5	9.2	Ro,
	3611.7	8.4	Ca,	3646.7	10.2	Ft,
	3613.7	8.5	Lv,	3647.6	9.7	Ly,
124606 U VIRGINIS—						
	3557.7	[12.5	Fe,	3605.6	10.8	Pt,
	3576.7	12.0	Fe,	3640.6	8.9	Pt,

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
130212 RV VIRGINIS—						
	3565.0	12.3	Nk.	3602.7	[12.8	Wf.
	3585.7	12.9	Wf,			
131283 U OCTANTIS—						
	3540.9	11.9	Bl,	3592.1	13.0	Bl.
	3555.0	12.1	Bl,			
132422 R HYDRAE—						
	3540.9	6.2	Bl,	3592.1	8.3	Bl,
	3556.9	6.7	Bl,	3594.0	8.2	Kd,
	3566.1	7.0	Bl,	3598 9	8.1	Bl,
	3577.0	8.0	Kd,	3605.6	8.5	Pt,
	3579.0	7.5	Bl,	3613.4	9.0	L.
	3584.4	8.1	L,			
132706 S VIRGINIS—						
	3552.8	8.3	Jb,	3609.6	9.4	Kl,
	3565.0	8.0	Nk,	3609.7	9.6	Wf,
	3585.7	8.7	Wf,	3613.6	9.6	Kl,
	3590.6	9.2	Ft,	3616.7	9.5	Sg,
	3602.6	9.3	Ca.	3618.6	10.0	Kl,
	3602.7	9.4	Wf,	3640.6	12.1	Pt,
	3605.6	9 3	Pt,	3643.6	10.0	Ft,
	3605.7	9.5	Sg,	3646.6	10.8	Ft.
133155 RV CENTAURI—						
	3540.9	7.8	Bl,	3579.0	7.5	Bl,
	3555.0	7.8	Bl,	3592.1	7.0	Bl,
	3567.1	7.2	Bl,	3598.9	7.2	Bl,
133273 T URSAE MINORIS—						
	3599.7	9.3	Lv,	3621.7	10.0	Lv,
	3599.7	9.0	Wf,	3623.8	10.6	Wf,
	3609.7	9.6	Lv,	3629.8	10.0	Br,
	3609.7	9.2	Wf,	3638 7	11.3	Wf.
	3616.7	10.3	Wf,			
133633 T CENTAURI—						
	3540.9	6.5	Bl,	3592.1	6.0	Bl,
	3556.9	6.5	Bl,	3594.0	6.1	Kd,
	3567.1	6.1	Bl,	3598.9	5.9	Bl,
	3577.0	6 3	Kd,	3615.0	6.1	Kd,
	3579.0	6.0	Bl,			
134236 RT CENTAURI—						
	3556.9	12.5	Bl,	3579.0	12.4	Bl,
	3567.1	12.7	Bl,	3595.9	12.0	Bl.
134440 R CANUM VENATICORUM—						
	3589.7	10.8	Lv,	3609.7	11.3	Lv,
	3599.7	11.1	Lv,	3612.7	10.4	Ly,
	3600.5	10.6	Ro,	3614.7	10.4	Ly,
	3604.5	10.6	Ro,	3618.7	11.1	Kl,
	3605.6	10.8	Pt,	3620.7	11.1	Kl,
	3606.7	10.2	Kl,	3622.7	11.5	Lv,
	3608 6	10.7	Ya,	3632.6	11.9	Pt.
	3609.6	10.8	M,			
134677 T APODIS—						
	3555.0	12.7	Bl,	3598.9	8.9	Bl.
	3595.9	9.0	Bl,			
135908 RR VIRGINIS—						
	3605.6	12.2	Pt.			
140113 Z BOOTIS—						
	3555.8	15.	Pa,	3616.7	13.5	Wf,
	3602.7	13.9	Wf,	3638.7	11.2	Wf.
	3611.8	13.8	Wf,			
140512 Z VIRGINIS—						
	3605.6	11.9	Pt.			
140528 RU HYDRAE—						
	3540.9	9.0	Bl,	3579.0	10.0	Bl,
	3555.0	9.8	Bl,	3595.9	9.7	Bl.
	3567.1	9.2	Bl,			
140959 R CENTAURI—						
	3540 9	6.4	Bl,	3579.0	7.7	Bl,
	3555.0	6.5	Bl,	3595.9	7.9	Bl.
	3567.1	7.4	Bl.			
141567 U URSAE MINORIS—						
	3557.1	9.5	Ch,	3617.6	11.2	Ya.
	3562.7	9.6	Fe.	3617.6	10.9	Fe,
	3576.6	10.2	Fe.	3621 7	11.6	Lv.
	3599.7	10.9	Lv.	3630.7	11.5	Br.
	3604.7	11.0	Lv.	3632.6	12.0	Pt.
	3605.6	10.9	Pt.	3634.6	11.9	Fe.
	3609.2	11.0	Ch.	3643.6	12.1	Fe.
	3613.7	11.2	Lv.			
141954 S BOOTIS—						
	3573.4	9.4	L,	3611.8	11.1	Wf,
	3579.5	9.2	Gi,	3613.8	11.3	Sg,
	3595.4	10.4	L,	3616.4	11.6	L,
	3602.7	10.6	Wf,	3616.7	11.3	Wf,
	3604.5	11.0	Ro,	3618.7	11.7	Sg.
	3604.8	11.0	Sg,	3623.8	12.5	Wf.
	3605.5	10.5	Gi.	3632.6	12.2	Pt.
	3605.7	10.4	Pt,	3638.7	12.5	Wf.
	3609.6	11.0	Ya,			
142539 V BOOTIS—						
	3538.6	11.2	Fe.	3609.6	8.8	Ya.
	3560.7	10.4	Fe.	3610.1	8.1	Kd,
	3565.0	10.7	Nk.	3613.6	8.5	O,
	3577.1	10.5	Kd.	3613.8	8.5	Sg,
	3573.4	10.2	L,	3616.4	8.9	L.
	3576.6	10.1	Fe.	3616.5	8.3	Ro,
	3581.6	9.9	L.	3617.6	8.1	Fe.
	3589.5	9.2	Ro.	3619.0	8.4	Kd.
	3595.4	9.0	L.	3623.6	8.5	M.
	3601.5	8.8	Ro.	3632.6	7.9	Pt.
	3604.5	8.5	Ro.	3634.6	8.6	Fe.
	3604.8	8.8	Sg.	3637.7	8.0	Sg.
	3605.7	8.5	Pt.	3643.6	8.0	Fe.
	3607.7	8.7	Ca.	3646.5	7.9	Ro.
	3608.7	8.2	M.	3649.6	8.0	Fe.
142584 R CAMELOPARDALIS—						
	3584.5	12.1	Gi.	3616.7	13.6	Wf.
	3602.7	12.8	Wf.	3623.8	13.5	Wf,
	3610.5	13.1	Gi.	3638.7	13.1	Wf.
	3611.8	13.4	Wf.			
143227 R BOOTIS—						
	3591.8	11.7	Sg.	3613.8	11.6	Sg,
	3604.5	11.9	Ro,	3632.6	11.7	Pt,
	3605.7	11.9	Pt.	3637.7	11.3	Sg.
144918 U BOOTIS—						
	3583.5	12.0	Gi.	3618.5	11.4	Gi.
	3605.4	11.8	Gi.			

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
145254 Y LUPI—						
	3540.9	10.4	Bl,	3579.0	11.7	Bl,
	3556.9	10.9	Bl,	3595.9	12.8	Bl.
	3567.1	11.2	Bl,			
145971 S APODIS—						
	3540.9	9.8	Bl,	3579.0	7.9	Bl,
	3556.9	10.2	Bl,	3595.9	10.0	Bl.
	3567.1	9.9	Bl,			
150018 RT LIBRAE—						
	3605.7	8.3	Pt,	3638.6	8.5	Pt.
	3609.6	8.2	Ya,			
150519 T LIBRAE—						
	3605.7	14.1	Pt.			
150605 Y LIBRAE—						
	3582.4	12.9	L,	3622.4	8.4	An,
	3610.4	10.1	L,	3638.6	8.9	Pt.
	3622.4	9.2	L,			
151520 S LIBRAE—						
	3549.2	8.6	Ch,	3605.2	8.8	Ch,
	3557.1	8.5	Ch,	3605.7	9.1	Pt,
	3575.2	8.5	Ch,	3610.4	10.0	L,
	3584.5	8.5	L,	3622.4	10.5	L,
	3590.6	9.3	O,	3638.6	11.2	Pt.
151714 S SERPENTIS—						
	3584.4	11.7	L,	3611.8	10.2	Wf,
	3602.3	11.1	Wf,	3613.4	10.5	L,
	3605.7	10.1	Pt,	3616.7	10.0	Wf,
	3605.4	11.2	L,	3623.8	9.3	Wf,
	3607.6	10.3	Ca,	3635.7	8.7	Pt,
	3609.6	10.4	Ya,	3638.7	8.7	Wf.
151731 S CORONAE BOREALIS—						
	3565.0	10.1	Nk,	3611.8	11.9	Wf,
	3601.6	11.5	Ya,	3616.8	12.0	Wf,
	3602.7	11.6	Wf,	3623.8	12.0	Wf,
	3604.8	12.1	Sg,	3635.7	12.1	Pt,
	3605.7	11.7	Pt,	3638.7	12.1	Wf.
151822 RS LIBRAE—						
	3540.9	10.9	Bl,	3584.5	9.3	L,
	3556.9	10.8	Bl,	3595.9	7.3	Bl,
	3567.1	9.9	Bl,	3610.4	7.8	L,
	3579.0	9.3	Bl,	3622.4	7.6	L.
152714 RU LIBRAE—						
	3565.0	8.7	Nk,	3610.4	11.0	L,
	3584.4	9.3	L,	3614.7	11.5	Sg,
	3601.6	10.0	Ya,	3617.6	11.0	Ya,
	3603.8	10.2	Sg,	3622.4	11.4	L,
	3605.7	10.6	Pt,	3635.7	13.0	Pt.
152849 R NORMAE—						
	3540.9	10.8	Bl,	3595.9	12.5	Bl.
	3556.9	11.8	Bl,			
153020 X LIBRAE—						
	3556.9	12.3	Bl.			
153215 W LIBRAE—						
	3555.8	14.6	Pa.			
153378 S URSAE MINORIS—						
	3565.0	8.5	Nk,	3611.7	8.7	Ca,
	3575.2	8.5	Nk,	3616.8	9.5	Wf,
	3589.5	8.5	Ro,	3618.7	9.5	Sg,
	3591.8	8.6	Sg,	3621.5	9.8	Cy,

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
153378 S URSAE MINORIS—Continued						
	3599.8	8.9	Wf,	3623.8	9.8	Wf,
	3600.5	8.8	Ro,	3635.7	9.3	Pt,
	3604.5	8.9	Ro,	3637.7	9.5	Sg,
	3605.7	8.6	Pt,	3638.7	9.9	Wf,
	3605.7	8.6	Sg,	3639.5	9.5	Cy,
	3609.7	8.9	Wf,	3643.5	10.4	Ro.
153620 U LIBRAE—						
	3555.8	13.9	Pa.			
154020 Z LIBRAE—						
	3556.9	13.2	Bl.			
154428 R CORONAE BOREALIS—						
	3489.7	6.0	Jb,	3609.7	7.0	Sg,
	3490.8	5.9	Jb,	3609.7	7.2	Wf,
	3495.9	6.0	Jb,	3610.0	7.3	Kd,
	3500.8	6.1	Jb,	3610.4	7.7	L,
	3500.8	5.9	Jb,	3610.6	7.0	Ft,
	3505.8	6.2	Jb,	3610.6	6.8	Pt,
	3526.0	8.3	Nk,	3611.5	7.6	L,
	3537.7	7.4	Fe,	3611.6	6.9	Ft,
	3540.1	7.5	Nk,	3611.8	7.2	Wf,
	3542.1	7.8	Ch,	3612.7	7.5	Ca,
	3543.1	7.8	Ch,	3612.7	7.2	Ly,
	3544.0	8.6	Nk,	3612.8	7.2	To,
	3544.1	9.0	Ch,	3612.8	7.1	Wf,
	3545.0	8.8	Nk,	3613.4	7.4	L,
	3547.1	[9.8	Ch,	3613.6	7.1	Gd,
	3548.0	10.5	Nk,	3613.6	7.2	O,
	3549.0	11.0	Nk,	3613.6	7.2	Ly,
	3549.1	10.9	Ch,	3613.6	6.8	Pt,
	3550.1	[10.7	Ch,	3613.7	7.2	Kl,
	3551.0	11.2	Nk,	3614.6	6.8	Pt,
	3552.0	11.3	Nk,	3614.7	6.6	Sg,
	3552.0	11.0	Jk,	3614.7	7.0	Ly,
	3552.1	[10.7	Ch,	3614.8	7.1	Wf,
	3553.1	[11.8	Ch,	3615.4	7.6	L,
	3556.0	12.6	Nk,	3615.8	7.1	Wf,
	3557.1	[11.8	Ch,	3616.7	7.0	Kl,
	3558.0	12.7	Nk,	3616.8	7.2	Wf,
	3562.6	11.3	Fe,	3617.5	6.8	Cy,
	3565.0	11.3	Nk,	3617.6	7.1	Gd,
	3571.1	[11.4	Ch,	3617.6	6.8	Pt,
	3572.1	11.3	Ch,	3617.6	6.8	Ly,
	3572.4	[10.7	Pe,	3617.7	7.1	Fe,
	3573.4	[10.7	Pe,	3617.7	7.1	Cd,
	3575.1	[10.7	Ch,	3618.4	7.4	L,
	3576.1	10.9	Nk,	3618.5	6.9	Gi,
	3576.4	11.3	Pe,	3618.7	6.8	Sg,
	3576.6	10.6	Fe,	3618.7	7.0	Kl,
	3577.0	11.1	Kd,	3618.8	6.9	Pt,
	3577.0	10.8	Nk,	3618.8	6.9	To,
	3577.6	11.1	L,	3619.0	7.4	Kd,
	3578.4	11.1	Pe,	3619.6	6.7	Pe,
	3578.7	10.5	To,	3619.6	7.2	O,
	3579.5	10.5	Gi,	3619.7	7.4	Ca,
	3581.5	10.3	L,	3619.8	7.0	Wf,
	3581.7	10.7	Wf,	3620.5	7.6	L,
	3582.7	9.4	To,	3620.6	6.7	Ly,
	3583.4	9.7	Pe,	3620.6	6.7	Pt,

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
154428 R. Cor. Bor.—Continued.						
	3584.4	9.4	L.	3620.7	7.0	Kl.
	3585.8	9.5	Wf.	3620.8	7.1	Wf.
	3587.7	9.0	To.	3621.7	6.7	Wf.
	3587.7	8.5	Sg.	3621.8	7.2	Wf.
	3590.6	8.1	Gd.	3622.4	7.5	L.
	3591.7	8.3	Pt.	3622.4	7.3	An.
	3591.8	7.8	Sg.	3622.6	6.9	Ft.
	3593.0	8.5	Nk.	3623.6	7.0	M.
	3593.5	8.2	Gi.	3623.8	7.0	Wf.
	3593.5	8.2	Gi.	3623.8	6.5	Pt.
	3593.7	8.2	Pt.	3625.7	6.9	Kl.
	3594.0	7.8	Sg.	3622.6	6.9	Ft.
	3593.0	8.5	Nk.	3623.6	7.0	M.
	3593.5	8.2	Gi.	3623.8	7.0	Wf.
	3593.4	8.2	L.	3623.8	6.5	Pt.
	3593.7	8.2	Pt.	3625.7	6.9	Kl.
	3594.0	7.7	Kd.	3626.7	6.9	Kl.
	3594.0	8.0	Nk.	3626.8	6.9	Wf.
	3594.7	8.0	Br.	3626.8	6.3	Pt.
	3594.7	8.0	To.	3626.7	7.1	Kd.
	3595.4	7.9	L.	3627.6	6.3	Pt.
	3595.4	8.0	An.	3627.7	6.7	Wf.
	3595.8	8.0	Pt.	3628.8	6.6	Wf.
	3596.0	8.0	Nk.	3629.7	6.4	Pt.
	3596.6	7.6	Gd.	3631.7	6.9	Kl.
	3596.6	8.1	Pt.	3632.4	6.9	L.
	3596.7	8.1	Wf.	3632.6	6.3	Pt.
	3597.7	7.8	Pt.	3632.7	6.5	Sg.
	3598.7	7.7	Pt.	3632.7	6.7	To.
	3598.6	7.7	Ca.	3633.6	6.7	Ly.
	3599.7	7.7	Pt.	3633.8	6.6	Wf.
	3599.8	7.6	Wf.	3633 8	6.2	Pt.
	3600.7	7.5	Wf.	3634.6	6.5	Fe.
	3600.7	7.5	Ca.	3634.8	6.6	Wf.
	3600.7	7.5	Pt.	3635.6	7.0	Ft.
	3601.6	7.6	Gi.	3635.6	6.4	Ly.
	3601.6	7 4	Ya.	3635.7	6.3	Pt.
	3601 6	7.3	Gd.	3635.8	6.6	Wf.
	3601.7	7.4	Br.	3636.7	7.5	Ct.
	3601.7	7.6	Ct.	3636.7	6.5	Ly.
	3601.7	7.5	Pt.	3637.5	6.5	Cy.
	3601.8	7.4	Wf.	3637.6	6.3	Pt.
	3602.4	7.6	L.	3637.7	6.2	Sg.
	3602.7	7.4	Wf.	3637.8	6.4	Wf.
	3603.0	7.7	Kd.	3638.6	6.3	Pt.
	3603.8	7.2	Sg.	3687.6	6.2	Ly.
	3604.7	6.2	Pt.	3638.8	6.4	Wf.
	3604 7	7.5	Wf.	3639.5	6.3	Cy.
	3605.0	7.5	Kd.	3639.7	6.6	Wf.
	3605.4	7.8	L.	3640.6	6.5	Ly.
	3605.7	7.2	Pt.	3640.7	6.3	Wf.
	3605.8	7.3	Wf.	3640.7	6.3	Pt.
	3606.6	7.4	Pt.	3641.6	6.3	Pt.
	3606.7	7.2	Kl.	3641.6	6.0	O.
	3606.8	7.3	Wf.	3642.6	6.2	Pt.
	3607.6	7.3	Gd.	3642.7	6.8	Wf.
	3607.6	7.1	Pt.	3642.7	6.2	Wf.
	3607.6	7.3	Gi.	3643.6	7.0	Ft.
	3607.7	7.4	Ca.	3643.7	6.2	Sg.
	3607.7	7.4	Cd.	3644.6	6.2	Fe.
	3607.7	7.0	Ly.	3644.7	6.3	Pt.
	3608.0	7.6	Kd.	3645.6	6.2	Pt.
	3608.6	7.4	M.	3646.6	6.2	Pt.
	3608.7	7.0	Pt.	3646.7	6.5	Ft.
	3608.7	7.1	Ly.	3647.6	6.4	Cd.
	3609.3	7.2	Ch.	3647.6	6.1	Ly.
	3609.5	7.6	L.	3648.6	6.4	Fe.
	3609.6	7.3	Pt.	3648.7	6.1	Ly.
	3609.6	7.3	Ly.	3649.7	6.3	Pt.
	3609.6	7.3	O.	3650.7	6.2	Pt.
	3609.7	7.2	Kl.	3651.7	6.3	Pt.
154536 X Coronae Borealis—						
	3605.7	12.6	Pt.	3635.7	10.9	Pt.
154615 R Serpentis—						
	3549.2	8.4	Ch.	3605.7	10.2	Pt.
	3576.4	10.1	Pe.	3607.6	10.6	Ca.
	3579.4	10.1	Pe.	3611.2	10.5	Ch.
	3583.4	10.1	Pe.	3613.6	10.6	O.
	3587.7	9.7	Sg.	3613.8	11.0	Sg.
	3588.6	9.6	O.	3617.6	11.0	Ya.
	3594.7	10.0	Br.	3638.6	11.4	Pt.
	3604.8	10.9	Sg.			
154639 V Coronae Borealis—						
	3594.7	10.2	Br.	3611.7	9.8	An.
	3599.8	9.9	Wf.	3616.8	9.9	Wf.
	3605.7	9.4	Pt.	3623.6	9.5	M.
	3607.6	10.2	Gd.	3623.8	9.6	Wf.
	3608.8	10.3	M.	3635.7	8.3	Pt.
	3609.7	10.2	Wf.	3638.7	9.5	Wf.
154736 R Lupi—						
	3614.6	10.5	Pt.			
155018 RR Librae—						
	3549 2	9.2	Ch.	3605.7	11.8	Pt.
	3557.1	9.5	Ch.	3610.4	12.0	L.
	3572.7	9.7	Ch.	3622.4	12.6	L.
	3582.4	10.6	L.			
155823 RZ Scorpii—						
	3605.7	10.5	Pt.	3638.6	8.9	Pt.
160021 Z Scorpii—						
	3584.5	12.2	L.	3610.4	12.2	L.
160118 R Herculis—						
	3549.2	9.7	Ch.	3638.6	14.0	Pt.
	3605.7	13.5	Pt.			
160210 U Serpentis—						
	3548.1	9.1	Nk.	3609.6	11.7	Ya.
	3565.0	9.2	Nk.	3609.7	11.4	Kl.
	3587.7	10 8	Sg.	3613.7	11.6	Kl.
	3593.0	11.6	Nk.	3618.6	12.3	Kl.
	3601.5	11.3	Ro.	3620.7	12.3	Kl.
	3604.8	11.6	Sg.	3631.6	13.5	Kl.
	3605.7	12.2	Pt.	3638.6	13.2	Pt.
160519 W Scorpii—						
	3590 8	[15.0	Pa.			

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
160625a RU HERCULIS—						
	3577.6	9.8	L.	3615.8	10.6	Wf,
	3602.7	10.6	Wf,	3622.5	10.5	L.
	3605.7	10.7	Pt.	3623.8	11.0	Wf,
	3609.7	10.7	Wf,	3638.6	11.7	Pt,
	3611.6	10.8	L.	3638.7	11.4	Wf.
160625b SX HERCULIS—						
	3577.6	9.3	L.	3618.8	7.7	Pt,
	3591.7	8.3	Pt,	3620.6	7.6	Pt.
	3593.5	8.6	L.	3622.4	7.8	L.
	3595.8	8.1	Pt,	3623.8	7.9	Wf,
	3597.8	8.1	Pt,	3626.8	7.9	Wf,
	3599.7	8.1	Pt.	3626.8	7.9	Pt,
	3599.7	8.3	Wf,	3632.6	8.0	Pt,
	3601.7	8.0	Pt,	3635.7	8.0	Pt,
	3604.7	8.0	Pt,	3637.6	8.0	Pt,
	3607.7	7.9	Pt,	3638.9	8.4	Wf,
	3609.7	8.2	L.	3640.7	8.3	Wf,
	3610.6	7.8	Pt.	3640.8	8.2	Pt.
	3611.8	7.8	L.	3642.6	8.1	Pt,
	3613.6	7.9	Pt.	3649.7	8.2	Pt.
	3615.8	7.7	Wf,			
161122a R SCORPII—						
	3609.6	13.0	M,	3638.7	12.0	Pt.
	3617.6	12.9	Pt,			
161122b S SCORPII—						
	3556.9	13.0	Bl,	3638.7	12.5	Pt.
	3617.0	13.0	Pt,			
161122c T SCORPII—						
	3609.6	10.0	M.			
161138 W CORONAE BOREALIS—						
	3602.7	12.5	Wf,	3616.8	10.7	Wf,
	3605.7	11.9	Pt,	3623.8	10.6	Wf,
	3611.8	11.9	Wf,	3638.7	10.2	Pt.
161607 W OPHIUCHI—						
	3584.5	13.9	L.	3638.7	13.6	Pt.
	3605.7	13.5	Pt,			
162112 V OPHIUCHI—						
	3565.0	8.2	Nk,	3607.6	8.0	Ca,
	3590.6	8.2	Gd,	3637.6	8.0	Ca,
	3605.7	7.3	Pt,	3638.7	7.2	Pt.
162119 U HERCULIS—						
	3579.4	9.7	Pe,	3607.5	10.2	Gi,
	3579.5	9.6	Gi,	3607.6	10.3	Ca,
	3583.4	10.0	Pe,	3611.8	10.7	Wf,
	3587.7	10.5	Sg,	3612.6	10.3	O,
	3594.8	10.4	Br,	3614.7	10.7	Sg,
	3602.7	10.1	Wf,	3638.7	11.2	Sg,
	3604.8	10.7	Sg,	3638.7	11.2	Pt,
	3605.7	10.0	Pt.	3638.7	11.0	Wf.
162319 Y SCORPII—						
	3582.5	13.9	Gi,	3605.4	13.7	Gi,
	3590.8	14.4	Pa,	3620.4	13.0	Gi.
162807 SS HERCULIS—						
	3577.6	10.8	L,	3613.4	11.6	L,
	3593.5	12.1	L,	3626.4	9.9	L.
	3594.8	12.2	Br,	3638.7	8.8	Pt.
	3607.6	11.7	Pt,			

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
162815 T OPHIUCHI—						
	3556.9	11.6	Bl,	3584.5	12.4	L,
	3567.1	11.8	Bl,	3610.4	12.6	L.
	3579.0	11.9	Bl,			
162816 S OPHIUCHI—						
	3556.9	9.9	Bl,	3607.6	11.3	Pt,
	3567.1	9.4	Bl,	3610.4	10.6	L,
	3579.0	9.5	Bl,	3622.4	11.3	L,
	3584.5	9.7	L.	3638.7	13.0	Pt.
	3596.1	10.0	Bl,			
163137 W HERCULIS—						
	3609.6	13.5	M,	3638.7	13.5	Pt.
163266 R DRACONIS—						
	3607.6	9.5	Pt,	3629.8	7.4	Br,
	3609.2	9.2	Ch,	3638.7	7.5	Pt,
	3619.6	8.3	O,	3640.6	7.3	Ca.
164319 RR OPHIUCHI—						
	3584.5	8.0	L,	3622.4	9.9	L,
	3607.6	9.0	Pt,	3638.7	10.6	Pt.
	3610.4	8.8	L,			
164715 S HERCULIS—						
	3518.0	10.6	Jk,	3609.7	9.0	Br,
	3565.0	11.5	Nk,	3619.7	8.3	Ca,
	3579.5	10.7	Gi,	3632.6	8.2	Ca,
	3602.6	8.1	Ca,	3638.7	8.0	Pt,
	3605.5	9.0	Gi,	3648.6	8.0	Ca.
	3607.6	9.1	Pt,			
164841 RS SCORPII—						
	3541.1	10.2	Bl,	3579.0	7.0	Bl,
	3556.9	8.9	Bl,	3596.2	6.5	Bl.
	3567.1	7.8	Bl,			
165030 RR SCORPII—						
	3541.1	11.4	Bl,	3579.0	9.2	Bl,
	3556.9	10.7	Bl,	3596.1	8.1	Bl,
	3567.1	10.3	Bl,	3619.0	7.6	Bl.
165031 RV HERCULIS—						
	3565.0	12.1	Nk,	3607.6	9.5	Pt,
	3573.0	10.1	Nk,	3607.7	10.1	Lv,
	3583.4	10.3	Pe,	3608.6	10.3	M,
	3587.7	9.5	Sg,	3616.7	11.2	Lv,
	3593.1	10.4	Nk,	3623.6	11.4	M,
	3599.7	10.1	Lv,	3628.7	11.5	Lv,
	3604.7	10.1	Lv,	3638.7	12.3	Sg,
	3605.7	10.2	Sg,	3638.7	12.5	Pt.
165636 RT SCORPII—						
	3541.1	9.1	Bl,	3579.0	8.3	Bl,
	3556.9	8.2	Bl,	3596.1	8.4	Bl.
	3567.1	8.2	Bl,			
170215 R OPHIUCHI—						
	3606.7	10.7	Kl,	3618.6	10.2	Kl,
	3607.6	10.6	Pt,	3634.7	9.4	Fe,
	3607.7	10.8	Ca,	3637.6	9.4	Ca,
	3609.7	10.7	Kl,	3638.7	9.3	Pt,
	3613.7	10.4	Kl,	3638.7	9.3	Sg,
	3616.2	10.8	Ch,	3641.6	8.9	Fe,
	3618.5	10.2	Fe,	3649.6	8.5	Fe.

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
170627 RT HERCULIS—						
	3601.8	12.0	Br.	3623.8	10.4	Wf,
	3602.7	11.6	Wf,	3638.7	10.0	Wf,
	3607.6	11.2	Pt.	3638.7	9.6	Pt.
	3616.8	10.7	Wf,			
170833 RW SCORPII—						
	3541.1	10.2	Bl,	3579.0	11.7	Bl,
	3557.0	11.0	Bl,	3596.1	11.7	Bl.
	3567.1	11.3	Bl,			
171401 Z OPHIUCHI—						
	3565.0	10.6	Nk,	3601.8	11.9	Br,
	3573.1	11.1	Nk,	3605.8	11.8	Gi,
	3579.5	11.2	Gi,	3607.6	12.2	Pt,
	3582.7	11.4	To,	3638.7	12.4	Pt.
	3587.7	11.3	To,			
171723 RS HERCULIS—						
	3549.0	11.9	Nk,	3607.6	8.5	Pt,
	3565.0	10.6	Nk,	3611.8	8.1	Wf,
	3573.1	9.5	Nk,	3613.7	7.5	Br,
	3576.4	9.4	Nk,	3616.8	7.9	Wf,
	3593.1	9.1	Nk,	3623.8	8.0	Wf,
	3599.0	8.7	Nk,	3638.7	8.0	Wf,
	3599.8	9.0	Wf,	3638.7	7.8	Pt.
172486 S OCTANTIS—						
	3557.0	12.9	Bl,	3579.0	12.1	Bl,
	3567.1	12.5	Bl,	3596.2	11.0	Bl.
172809 RU OPHIUCHI—						
	3601.6	11.7	O,	3618.7	10.1	To,
	3601.8	11.5	Br,	3632.7	9.8	To,
	3607.6	11.3	Pt,	3638.7	11.3	Pt.
	3611.7	10.6	To,			
173212 RT SERPENTIS—						
	3613.4	9.6	L,	3626.4	9.6	L.
173543 RU SCORPII—						
	3567.1	12.0	Bl,	3579.0	12.0	Bl,
	3576.0	12.7	Bl,	3596.2	11.7	Bl.
174162 W PAVONIS—						
	3480.1	10.2	Bl,	3500.2	10.4	Bl,
	3489.1	10.4	Bl,	3507.1	10.6	
174406 RS OPHIUCHI—						
	3607.6	11.2	Pt,	3638.7	11.0	Pt.
175458a T DRACONIS—						
	3629.9	11.9	Br.			
175458b UY DRACONIS—						
	3629.9	10.8	Br.			
175519 RY HERCULIS—						
	3549.2	8.9	Ch,	3607.7	11.9	Pt,
	3578.4	10.2	Pe,	3611.7	12.0	To,
	3578.7	10.2	To,	3613.8	12.9	Br,
	3582.7	10.5	To,	3614.7	12.5	Lv,
	3587.7	10.3	To,	3618.7	11.9	To,
	3594.7	11.2	To,	3624.7	13.3	Lv,
	3599.7	11.2	Lv,	3638.7	14.0	Pt.
	3604.7	11.8	Lv.			
175654 V DRACONIS—						
	3582.7	10.3	To,	3607.7	10.3	Pt,
	3587.7	9.9	To,	3638.7	11.7	Pt.
180531 T HERCULIS—						
	3518.0	7.8	Jb,	3602.8	13.2	Wf,
	3549.0	8.8	Nk,	3607.7	13.3	Pt,
	3549.2	8.8	Ch,	3609.5	14.0	L,
	3565.0	9.6	Nk,	3609.7	13.6	Wf,
	3573.4	11.1	Pe,	3616.8	13.4	Wf,
	3575.2	10.6	Nk,	3622.4	13.6	L,
	3577.6	11.4	L,	3623.8	13.0	Wf,
	3578.4	11.2	Pe,	3633.7	12.0	Br,
	3582.8	11.7	To,	3638.7	11.5	Pt,
	3583.4	11.3	Pe,	3638.7	11.6	Wf,
	3587.7	11.8	To,	3643.7	11.0	Sg,
	3593.0	11.9	Nk,	3648.7	10.3	Ca.
180565 W DRACONIS—						
	3604.7	13.7	Lv,	3614.7	14.0	Lv.
180666 X DRACONIS—						
	3604.7	11.3	Lv,	3614.7	14.5	Lv,
	3607.7	11.4	Pt,	3628.7	12.2	Lv,
	3609.8	11.2	Br,	3638.7	12.0	Pt.
180911 NOVA OPHIUCHI #4—						
	3607.7	13.0	Pt,	3638.7	13.2	Pt.
	3622.5	13.1	L,			
181031 TV HERCULIS—						
	3593.5	10.3	L,	3622.4	9.6	L.
	3611.6	9.9	L,			
181103 RY OPHIUCHI—						
	3579.5	10.2	Gi,	3620.8	13.0	Br,
	3602.8	12.7	Wf,	3621.6	13.5	Gi,
	3604.8	12.4	Lv,	3623.8	13.4	Wf,
	3605.5	12.5	Gi,	3624.7	13.3	Lv,
	3607.7	12.9	Pt,	3638.7	13.3	Wf,
	3609.7	13.2	Wf,	3638.7	13.0	Pt,
	3614.7	13.2	Lv,	3643.7	13.0	Br.
	3616.8	13.3	Wf,			
181136 W LYRAE—						
	3587.7	10.8	Sg,	3616.8	8.8	Wf,
	3591.6	10.0	O,	3618.7	8.8	Sg,
	3599.8	9.5	Wf,	3619.7	8.7	Ca,
	3601.7	9.4	Ca,	3623.8	8.6	Wf,
	3602.4	9.6	L,	3626.4	8.7	L,
	3604.7	9.2	Wf,	3636.7	9.1	Ct,
	3605.7	9.0	Sg,	3638.7	8.3	Wf,
	3607.7	9.2	Pt,	3640.7	8.2	Ca,
	3608.6	9.2	M,	3642.7	8.0	Ct,
	3609.8	9.4	Wf,	3643.8	8.5	Sg,
	3613.4	9.0	L,	3647.7	8.5	Ca.
182133 RV SAGITTARII—						
	3541.1	8.5	Bl,	3579.0	7.8	Bl,
	3563.2	7.8	Bl,	3596.1	8.1	Bl.
	3567.1	7.6	Bl.			
182224 SV HERCULIS—						
	3619.5	13.8	L,	3638.7	13.5	Pt.
183308 X OPHIUCHI—						
	3576.1	8.0	Nk,	3622.5	8.4	L,
	3593.5	7.9	L,	3634.4	9.0	Cy,
	3601.8	8.7	O,	3635.6	8.6	Fe,
	3607.7	8.0	Pt,	3638.7	8.4	Pt,
	3611.6	8.2	L,	3643.6	8.6	Fe,
	3618.6	8.6	Fe,	3649.6	8.5	Fe.

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
184134 RY LYRAE—						
	3607.7	14.3	Pt.			
184205 R SCUTI—						
	3549.0	5.7	Nk,	3614.6	6.1	Lv,
	3555.3	5.0	Ch,	3616.6	6.2	Pt,
	3565.0	5.8	Nk,	3616.7	6.1	Kl,
	3577.0	6.6	Nk,	3617.6	5.8	Ly,
	3576.0	6.9	Nk,	3617.6	6.1	Pt,
	3577.2	6.6	Kd,	3618.4	6.3	An,
	3577.6	5.5	L,	3618.6	6.1	Pt,
	3580.4	6.8	An,	3618.7	6.2	Kl,
	3581.5	6.4	L,	3618.7	6.1	Sg,
	3582.2	6.2	Nk,	3619.0	5.9	Kd,
	3582.4	6.6	An,	3619.6	6.1	Pt,
	3585.1	5.9	Kd,	3619.6	5.8	O,
	3587.7	6.0	Sg,	3619.7	5.8	Ca,
	3589.5	6.5	Ro,	3620.6	6.1	Pt,
	3590.4	6.5	An,	3620.6	6.1	Ly,
	3591.1	5.9	Kd,	3620.7	6.1	Kl,
	3591.7	6.3	Pt,	3621.5	6.0	Cy,
	3593.5	6.6	L,	3621.7	6.1	Pt,
	3593.7	6.9	Pt,	3622.0	5.8	Kd,
	3594.0	5.8	Kd,	3622.4	6.0	An,
	3594.7	6.3	Sg,	3622.5	5.9	L,
	3595.8	6.3	Pt,	3623.6	6.0	Pt,
	3596.6	6.2	Pt,	3626.7	5.9	Kl,
	3597.0	5.7	Kd,	3626.8	6.1	Pt,
	3597.7	6.1	Pt,	3627.6	6.0	Pt,
	3598.6	5.9	Pt,	3627.6	6.1	Ca,
	3599.7	6.0	Pt,	3629.7	5.9	Pt,
	3600.6	5.9	Ca,	3631.4	5.8	An,
	3600.7	6.0	Pt,	3631.7	5.9	Kl,
	3601.4	6.0	An,	3632.4	5.9	An,
	3601.5	6.1	Ro,	3632.6	5.4	Ca,
	3601.7	6.1	Pt,	3632.7	5.5	Pt,
	3602.4	6.1	L,	3632.7	5.7	Sg,
	3602.6	6.0	Ca,	3633.7	5.4	Ca,
	3603.0	5.6	Kd,	3633.8	5.4	Pt,
	3603.8	6.1	Sg,	3634.5	6.1	Cy,
	3604.5	6.0	Ro,	3635.6	5.4	Ca,
	3604.7	6.2	Pt,	3635.7	5.5	Pt,
	3605.6	5.6	Kd,	3636.6	5.4	Ca,
	3605.4	5.9	An,	3636.6	6.0	Ly,
	3605.7	6.2	Pt,	3636.7	6.6	Ct,
	3606.6	6.4	Pt,	3637.6	5.4	Pt,
	3606.7	6.1	Kl,	3637.7	5.4	Ca,
	3607.6	6.2	Pt,	3638.6	5.5	Pt,
	3607.7	6.0	Ly,	3639.5	5.8	Cy,
	3607.7	6.0	Ca,	3639.6	5.3	Ca,
	3607.8	5.6	Cd,	3640.6	5.3	Ca,
	3608.0	5.6	Kd,	3640.7	5.5	Pt,
	3608.7	6.1	Pt,	3640.7	5.0	Sg,
	3609.2	6.2	Ch,	3641.6	5.4	Pt,
	3609.4	5.9	An,	3642.5	5.9	Ro,
	3609.6	5.8	Lv,	3642.6	5.4	Pt,
	3609.6	6.1	Pt,	3642.7	5.0	Ct,
	3609.7	6.1	Kl,	3643.5	5.8	Ro,
	3609.7	6.1	Sg,	3644.7	5.6	Pt,
	3610.1	5.7	Kd,	3645.5	5.6	Ro,
	3610.7	6.1	Pt,	3645.6	5.5	Pt,
	3611.4	6.0	An,	3646.5	5.6	Ro,
	3611.7	6.2	Ca,	3646.6	5.8	Pt,
	3612.1	5.8	Kd,	3647.6	5.2	Ca,
	3612.7	6.2	Ca,	3647.6	6.1	Ly,
	3613.4	5.9	L,	3647.6	5.5	Cd,
	3613.6	5.9	O,	3648.7	5.2	Ca,
	3613.7	6.0	Kl,	3649.7	5.6	Pt,
	3613.7	6.3	Pt,	3650.7	5.5	Pt,
	3614.4	6.0	An,	3651.6	5.2	Ca,
	3614.6	6.2	Pt,	3651.7	5.4	Pt.
184243 RW LYRAE—						
	3607.7	14.6	Pt,	3638.7	13.6	Pt.
184300 NOVA AQUILAE #3—						
	3549.0	10.3	Nk,	3609.7	10.0	Sg,
	3558.0	10.4	Nk,	3612.5	10.5	Ro,
	3563.5	10.2	Ch,	3612.7	10.1	To,
	3576.0	10.1	Nk,	3614.6	10.7	Pt,
	3583.7	9.7	To,	3616.5	10.7	Ro,
	3590.5	10.5	Ro,	3618.7	10.3	To,
	3592.8	10.2	Sg,	3632.7	10.7	Pt,
	3593.0	10.4	Nk,	3632.7	9.9	To,
	3593.5	10.3	Gi,	3632.7	10.2	Sg,
	3600.5	10.5	Ro,	3635.6	10.4	Ca,
	3602.6	10.2	Ca,	3642.5	10.3	Ro,
	3603.5	10.5	Ro,	3642.6	10.7	Pt,
	3604.5	10.2	Ro,	3643.5	10.3	Ro,
	3604.7	10.6	Pt,	3643.7	10.2	Sg,
	3605.5	10.4	Ro,	3645.5	10.5	Ro,
	3608.1	10.2	Ch,	3646.5	10.6	Ro.
185437 S CRUCIS AUS.—						
	3563.2	12.1	Bl,	3579.0	11.5	Bl,
	3567.1	11.3	Bl,	3596.1	11.5	Bl.
185437a R CRUCIS AUS—						
	3563.2	12.5	Bl,	3579.0	13.0	Bl.
	3567.1	13.0	Bl,			
185634 Z LYRAE—						
	3591.6	9.7	O,	3614.7	10.0	Br,
	3593.5	9.6	L,	3623.6	10.2	L,
	3608.6	9.8	M,	3630.5	10.6	L,
	3613.5	9.9	L,	3638.7	11.1	Pt.
	3613.6	10.0	Pt.			
185737 RT LYRAE—						
	3620.7	[13.0	Br,	3643.7	11.0	Br.
190108 R AQUILAE—						
	3591.6	6.6	O,	3611.7	7.4	Ca,
	3605.2	7.5	Ch,	3638.7	8.4	Pt,
	3607.7	7.0	Pt,	3640.7	8.2	Ca.
190529 V LYRAE—						
	3607.7	11.7	Pt,	3640.6	12.7	Pt.
190818 RX SAGITTARII—						
	3613.7	11.0	Pt,	3640.6	13.8	Pt.
	3614.2	11.6	Ch,			
190819a RW SAGITTARII—						
	3613.7	9.0	Pt,	3640.6	9.0	Pt.
	3614.2	9.3	Ch,			
190819b BH SAGITTARII—						
	3613.7	13.6	Pt,	3640.6	13.3	Pt.

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
190907 TY AQUILAE—						
	3642.6	10.0	Pt.			
190925 S LYRAE—						
	3602.4	13.5	L,	3614.7	12.5	Lv,
	3604.7	12.9	Lv,	3624.7	12.6	Lv,
	3607.7	13.3	Pt,	3626.4	12.1	Lv,
	3613.1	12.5	Ch,	3642.6	12.5	Pt.
	3613.5	12.9	Lv,			
190926 X LYRAE—						
	3607.7	9.0	Pt,	3642.6	8.9	Pt.
190933a RS LYRAE—						
	3604.8	11.9	Lv,	3617.6	10.9	Pt,
	3614.7	11.0	Lv,	3628.7	10.8	Lv,
	3614.7	11.2	Br,	3642.6	10.8	Pt.
190941 RU LYRAE—						
	3555.8	15.5	Pa,	3618.8	15.	Pa.
	3583.8	15.5	Pa,			
190967 U DRACONIS—						
	3610.6	12.6	Pt,	3642.6	12.4	Pt,
	3617.1	12.5	Ch,	3643.8	12.3	Br.
191007 W AQUILAE—						
	3608.2	11.9	Ch,	3620.8	12.0	Br.
191017 T SAGITTARII—						
	3608.1	8.2	Ch,	3614.2	8.4	Ch,
	3610.6	8.5	Pt,	3642.6	9.4	Pt.
191019 R SAGITTARII—						
	3561.2	9.8	Ch,	3638.7	11.0	Sg,
	3610.6	11.8	Pt,	3642.6	12.7	Pt.
191033 RY SAGITTARII—						
	3553.3	[10.0	Ch,	3622.4	9.9	L,
	3577.6	[11.0	L,	3623.8	9.4	Pt,
	3581.5	[10.5	L,	3632.4	10.1	L,
	3593.5	[11.0	L,	3632.6	10.5	Pt,
	3605.2	[10.0	Ch,	3635.7	10.8	Pt,
	3605.7	[12.0	Pt,	3637.6	[10.0	Pt.
	3610.4	11.0	L,	3638.6	11.2	Pt,
	3610.7	[11.5	Pt,	3640.7	12.0	Pt,
	3613.5	10.7	L,	3641.6	12.0	Pt,
	3613.7	12.1	Pt,	3642.6	12.2	Pt,
	3614.6	11.8	Pt,	3644.7	12.4	Pt,
	3616.2	9.7	Ch,	3645.6	12.7	Pt,
	3617.6	10.5	Pt,	3646.6	13.2	Pt,
	3618.8	10.8	Pt,	3649.7	13.5	Pt,
	3620.7	10.0	Pt,	3650.7	[12.0	Pt,
	3621.7	9.9	Pt,	3651.7	[9.0	Pt.
	3622.3	9.5	Ch,			
191319 S SAGITTARII—						
	3563.2	13.8	Bl,	3610.6	10.9	Pt,
	3579.0	11.9	Bl,	3611.7	10.6	Ca,
	3596.1	10.9	Bl,	3620.4	10.8	Gi,
	3606.8	11.0	Sg,	3638.7	11.4	Sg,
	3607.5	10.8	Gi,	3642.6	11.2	Pt.
191331 SW SAGITTARII—						
	3563.2	11.5	Bl,	3596.2	11.2	Bl.
	3579.0	11.3	Bl,			
191350 TZ CYGNI—						
	3582.8	11.0	To,	3610.6	10.6	Pt,
	3587.7	10.6	To,	3612.7	10.6	To,
	3594.7	10.7	To,	3618.7	10.8	To,
	3610.6	10.8	O,	3642.6	10.6	Pt.
	3607.6	10.1	Gd,			
191637 U LYRAE—						
	3610.6	11.7	Pt,	3642.6	11.6	Pt.
193311 RT AQUILAE—						
	3590.6	6.2	O,	3621.7	8.8	Br,
	3606.1	9.3	Ch,	3642.6	10.0	Pt.
	3610.6	8.3	Pt,			
193449 R CYGNI—						
	3518.0	9.6	Jb,	3611.7	6.5	To,
	3559.2	7.8	Ch,	3611.8	6.3	Wf,
	3572.2	6.9	Ch,	3613.6	6.4	Kl,
	3573.4	6.2	Pe,	3614.7	6.6	Sg,
	3578.4	6.2	Pe,	3614.8	6.7	Wf,
	3580.8	6.4	Jb,	3617.6	6.5	Cy,
	3581.4	6.6	Pe,	3617.6	6.0	Gd,
	3582.8	6.2	To,	3618.7	6.5	Kl,
	3587.7	6.4	To,	3618.7	6.6	To,
	3588.6	6.9	O,	3620.6	6.6	Kl,
	3592.8	6.2	Sg,	3623.6	5.8	M,
	3594.7	6.1	To,	3623.8	6.6	Wf,
	3598.6	6.5	Ca,	3624.7	6.6	Lv,
	3599.8	6.8	Wf,	3626.6	6.6	Kl,
	3601.6	6.4	Gd,	3629.7	7.0	Sg,
	3603.8	6.3	Sg,	3631.6	6.6	Kl,
	3604.7	6.4	Pt,	3632.6	6.9	Ca,
	3604.7	6.7	Wf,	3632.7	7.0	To,
	3605.7	6.5	Kl,	3634.5	6.5	Cy,
	3606.1	6.4	Ch,	3635.7	6.8	Pt,
	3607.6	6.7	Gd,	3638.7	6.9	Wf,
	3608.6	6.2	M,	3639.5	6.5	Cy,
	3609.6	6.4	Kl,	3640.7	8.0	Sg,
	3609.7	6.4	Lv,	3647.5	7.8	Ca.
	3611.6	6.6	Ca.			
193509 RV AQUILAE—						
	3583.7	11.6	To,	3611.8	10.7	To,
	3598.7	10.7	To,	3615.8	10.8	Br,
	3590.6	10.8	O,	3618.8	10.8	To,
	3592.8	10.7	To,	3632.7	10.9	To,
	3594.7	10.5	To,	3635.7	12.1	Pt.
	3604.7	10.5	Pt,			
193972 T PAVONIS—						
	3541.1	8.2	Bl.	3579.0	8.6	Bl,
	3563.2	8.7	Bl,	3596.2	9.5	Bl.
194048 RT CYGNI—						
	3518.0	9.0	Jb,	3608.6	9.7	M,
	3582.4	11.4	Gi,	3614.7	9.5	Sg,
	3592.8	9.1	Sg,	3617.6	9.3	Gd,
	3597.7	9.5	Sg,	3623.6	9.0	M,
	3601.4	9.9	Gi,	3629.7	8.8	Sg,
	3603.8	9.5	Sg,	3635.7	8.5	Pt,
	3604.7	9.8	Pt,	3640.7	8.0	Sg,
	3606.1	9.8	Ch,	3647.5	8.2	Ca.
	3607.6	9.8	Gd,			

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
194348 TU CYGNI—				
	3604.7	12.6 Pt,	3624.7	12.5 Lv,
	3609.7	13.1 Lv,	3635.7	11.7 Pt.
194604 X AQUILAE—				
	3604.7	13.9 Wf,	3623.8	14.3 Wf,
	3609.7	13.6 M,	3638.7	[14.4 Wf.
	3614.8	14.0 Wf,		
194632 χ CYGNI—				
	3611.2	11.4 Ch,	3635.7	9.1 Pt,
	3612.6	11.0 Ca,	3639.8	9.0 M,
	3613.7	11.3 Pt,	3640.6	8.5 Ca,
	3615.8	11.0 Br,	3647.6	8.3 Ca,
	3623.6	10.0 M,	3649.7	7.9 Pt.
193929 RR SAGITTARII—				
	3541.1	11.6 Bl,	3596.2	12.5 Bl.
	3563.2	11.9 Bl,		
195142 RU SAGITTARII—				
	3541.1	11.8 Bl,	3596.2	11.1 Bl.
	3563.2	12.5 Bl,		
195202 RR AQUILAE—				
	3583.7	9.5 To,	3611.8	9.8 To,
	3587.8	9.6 To,	3612.7	9.8 To,
	3592.8	9.7 To,	3618.8	9.8 To,
	3594.8	9.6 To,	3632.7	10.5 To,
	3610.7	9.3 Pt,	3640.8	10.4 Pt.
195553 NOVA CYGNI '23—				
	3549.0	10.8 Nk,	3612.5	11.0 Ro,
	3593.7	10.9 Pt,	3614.6	11.0 Pt,
	3596.6	11.0 Pt,	3619.6	10.9 Pt,
	3599.7	11.0 Pt,	3620.6	11.1 L,
	3602.4	10.5 L,	3627.6	11.0 Pt,
	3604.7	10.8 Pt,	3632.6	10.9 Pt,
	3605.5	11.0 Ro,	3637.6	10.8 Pt,
	3606.6	11.1 Pt,	3641.6	11.0 Pt,
	3608.6	10.5 Gd,	3644.7	10.8 Pt,
	3609.6	10.9 Pt,	3649.7	10.9 Pt,
	3611.2	10.8 Ch,	3651.9	11.3 Ca.
195849 Z CYGNI—				
	3602.8	14.0 Wf,	3619.8	14.2 Wf,
	3604.7	14.0 Wf,	3623.9	14.2 Wf,
	3609.8	14.1 Wf,	3637.7	14.0 Wf,
	3610.7	12.3 Pt,	3640.7	14.1 Wf,
	3611.8	14.2 Wf,	3642.6	12.5 Pt,
	3614.8	14.1 Wf,	3642.7	14.1 Wf.
195855 S TELESCOPII—				
	3563.2	12.7 Bl,	3596.2	13.1 Bl.
200212 SY AQUILAE—				
	3605.7	12.2 Wf,	3614.8	12.4 Wf,
	3605.5	12.0 L,	3619.5	12.4 L,
	3610.7	12.5 Pt,	3626.8	12.0 Wf,
	3615.8	11.9 Br,	3638.8	13.4 Wf,
	3618.5	12.4 L,	3642.6	13.0 Pt.
200514 R CAPRICORNI—				
	3590.8	11.2 Pa,	3616.7	12.0 Lv,
	3593.5	10.5 Gi,	3618.8	12.0 Pa,
	3604.8	11.6 Lv,	3620.5	11.5 Gi,
	3608.8	11.7 Pa,	3642.6	12.6 Pt.
	3610.7	11.8 Pt,		
200747 R TELESCOPII—				
	3596.2	14.0 Bl.		
200715a S AQUILAE—				
	3582.5	9.7 Kd,	3611.8	9.1 Wf,
	3594.0	10.1 Kd,	3614.8	9.2 Wf,
	3599.8	9.5 Wf,	3615.8	9.2 Br,
	3601.4	9.4 Gi,	3618.5	9.1 Gi,
	3605.7	9.1 Wf,	3623.6	8.7 M,
	3607.2	9.5 Ch,	3626.8	9.0 Wf,
	3608.8	9.0 M,	3637.7	9.4 Wf,
	3609.6	9.2 Gd,	3642.6	9.5 Pt.
	3610.7	8.8 Pt,		
200715b RW AQUILAE—				
	3608.8	8.8 M,	3610.7	9.3 Pt,
	3609.6	9.1 Gd,	3642.6	9.0 Pt.
200812 RU AQUILAE—				
	3605.7	14.0 Wf,	3616.7	13.5 Lv,
	3614.8	14.1 Wf,	3637.7	[14.1 Wf.
200822 W CAPRICORNI—				
	3610.7	12.6 Pt,	3642.6	12.2 Pt.
200906 Z AQUILAE—				
	3579.6	10.1 Gi,	3615.8	13.0 Br,
	3607.5	12.7 Gi,	3642.6	12.4 Pt.
	3610.7	12.8 Pt,		
200916 R SAGITTAE—				
	3608.8	9.3 M,	3623.6	9.1 M.
200938 RS CYGNI—				
	3562.3	8.2 Ch,	3613.4	8.2 L,
	3572.2	8.3 Ch,	3617.6	8.8 Gd,
	3602.4	8.0 L,	3617.7	8.3 Sg,
	3605.7	8.5 Sg,	3622.4	9.0 An,
	3608.7	8.5 M,	3623.6	8.6 M,
	3610.7	7.8 Pt,	3640.7	8.9 Sg,
	3613.1	8.8 Ch,	3642.6	8.2 Pt.
201008 R DELPHINI—				
	3605.8	11.5 Wf,	3616.4	11.9 L,
	3605.5	11.5 L,	3637.7	12.3 Wf,
	3610.7	11.5 Pt,	3642.7	12.5 Pt,
	3615.9	11.5 Br,	3644.7	12.5 Br.
201121 RT CAPRICORNI—				
	3577.6	6.6 L,	3620.6	6.6 L,
	3605.1	7.4 Kd,	3642.6	6.3 Pt,
	3610.1	7.4 Kd.		
201130 SX CYGNI—				
	3591.6	10.1 O,	3622.8	11.2 Br,
	3604.7	10.9 Wf,	3623.6	11.0 M,
	3608.6	10.8 M,	3637.7	11.7 Wf,
	3613.6	10.8 Pt,	3640.7	12.6 Pt,
	3614.8	10.8 Wf,	3644.7	11.8 Br,
	3617.6	10.4 Gd.		
201139 RT SAGITTARII—				
	3514.1	11.7 Bl,	3563.2	13.0 Bl.
201437 P CYGNI—				
	3578.4	4.9 Pe.		
201437b WX CYGNI—				
	3604.7	10.6 Wf,	3618.7	10.8 Lv,
	3605.7	9.5 Sg,	3620.7	10.4 Kl,
	3605.7	10.2 Kl,	3622.8	10.6 Br,
	3608.7	10.8 M,	3623.6	10.6 M,

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
201437b WX CYGNI—Continued				
	3611.8	10.5 Wf,	3626.6	10.5 Kl,
	3613.7	10.4 Kl,	3631.7	10.5 Kl,
	3613.7	10.2 Pt,	3637.7	10.5 Wf,
	3614.8	10.8 Wf,	3640.7	10.6 Sg,
	3617.7	10.6 Sg,	3640.7	10.5 Pt,
	3618.7	10.4 Kl.		
201647 U CYGNI—				
	3517.9	8.4 Jb,	3608.6	7.2 M,
	3576.4	8.0 Pe,	3610.7	6.8 Pt,
	3580.9	7.1 Jb,	3616.5	7.6 Ro,
	3589.5	7.4 Ro,	3617.6	7.7 Gd,
	3592.8	7.5 Sg,	3623.6	7.5 M,
	3600.5	7.2 Ro,	3633.7	7.6 Sg,
	3605.5	7.4 Ro,	3640.7	7.0 Pt,
	3606.8	7.6 Sg,	3642.5	7.7 Ro,
	3607.5	7.5 Ro,	3646.5	7.8 Ro,
202240 U MICROSCOPII—				
	3541.1	10.3 Bl,	3579.0	11.9 Bl,
	3563.3	11.3 Bl,	3596.2	12.5 Bl.
202539 RW CYGNI—				
	3623.6	9.0 M.		
202622 RU CAPRICORNI—				
	3605.6	10.5 Gi,	3620.5	10.7 Gi.
202817 Z DELPHINI—				
	3607.8	13.8 Lv,	3618.7	(14.0 Wf,
	3610.7	14.5 Pt	3637.7	(14.3 Wf.
202946 SZ CYGNI—				
	3593.7	9.4 Pt,	3623.6	10.2 M,
	3595.8	9.6 Pt,	3627.6	9.9 Pt,
	3597.7	9.8 Pt,	3632.6	9.0 Pt,
	3601.7	8.9 Pt,	3635.7	9.2 Pt,
	3604.7	9.0 Pt,	3637.6	9.4 Pt,
	3606.6	9.2 Pt,	3640.7	9.9 Pt,
	3608.7	9.7 M,	3644.7	9.4 Pt,
	3613.7	9.8 Pt,	3649.7	8.9 Pt,
	3617.6	9.0 Pt.		
202954 ST CYGNI—				
	3604.8	13.1 Wf,	3623.6	12.6 M,
	3610.7	13.0 Pt,	3637.7	13.4 Wf,
	3614.8	13.3 Wf,	3642.7	13.6 Pt.
203226 V VULPECULAE—				
	3610.7	8.8 Pt,	3642.7	8.6 Pt.
203429 R MICROSCOPII—				
	3563.3	13.8 Bl,	3596.2	10.7 Bl,
	3579.0	12.7 Bl.		
203611 Y DELPHINI—				
	3606.8	13.6 Wf,	3617.6	13.8 Pt,
	3614.8	13.5 Wf,	3637.7	13.3 Wf,
	3615.9	13.2 Br,	3640.7	13.2 Pt.
203816 S DELPHINI—				
	3580.9	10.0 Jb,	3623.6	9.7 M,
	3610.8	10.0 M,	3642.7	10.8 Pt,
	3613.7	9.3 Pt.		

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
203847 V CYGNI—				
	3555.8	10.5 Pa,	3618.7	12.0 Lv,
	3583.8	10.0 Pa,	3618.8	10.6 Pa,
	3593.4	10.0 Gi,	3623.6	11.4 M,
	3604.8	11.1 Wf,	3634.7	11.2 Br,
	3610.7	11.7 Pt,	3637.7	10.9 Wf,
	3614.8	11.1 Wf,	3642.7	10.8 Pt.
203905 Y AQUARII—				
	3608.7	10.0 Sg,	3633.7	9.5 Br,
	3610.7	11.4 Pt,	3640.7	9.2 Pt.
204016 T DELPHINI—				
	3555.8	14.4 Pa,	3614.8	13.8 Wf,
	3580.9	[14 Jb,	3615.9	13.5 Br,
	3583.8	14.3 Pa,	3617.6	14.8 Pt,
	3604.8	14.4 Wf,	3618.8	12.9 Pa,
	3608.8	13.6 Pa,	3637.7	12.8 Wf,
	3609.7	13.6 M,	3640.7	12.7 Pt.
204102 V AQUARII—				
	3610.7	8.1 Pt,	3640.7	8.8 Pt,
204104 W AQUARII—				
	3582.6	9.6 Gi,	3618.6	11.5 L,
	3605.6	10.1 L,	3633.7	11.5 Br,
	3607.5	10.4 Gi.		
204318 V DELPHINI—				
	3584.6	12.6 Gi,	3609.7	13.4 M,
	3607.5	12.9 Gi,	3614.8	[14.0 Wf,
204405 T AQUARII—				
	3605.2	8.7 Ch,	3617.8	9.5 M,
	3606.8	8.7 Sg,	3633.7	11.2 Br,
	3610.7	9.2 Pt,	3640.7	11.4 Pt,
	3612.7	8.8 Ca.		
204846 RZ CYGNI—				
	3555.8	11.3 Pa,	3618.7	12.3 Lv,
	3583.8	11.4 Pa,	3618.8	12.5 Pa,
	3604.8	12.2 Wf,	3634.7	13.0 Br,
	3608.8	12.4 Pa,	3637.7	12.4 Wf,
	3610.7	12.3 Pt,	3642.7	13.0 Pt.
	3614.9	12.3 Wf.		
204954 S INDI—				
	3563.3	14.0 Bl.		
205017 X DELPHINI—				
	3606.8	10.7 Wf,	3618.8	11.8 Lv,
	3607.8	11.7 Lv,	3622.8	12.0 Br,
	3610.7	11.6 Pt,	3637.7	12.8 Wf,
	3615.8	11.7 Wf.		
205017 — DELPHINI—				
	3607.8	12.7 Lv,	3618.8	12.7 Lv.
205923 R VULPECULAE—				
	3579.6	9.2 Gi,	3611.9	9.0 Wf,
	3593.5	8.9 Gi,	3615.8	9.4 Wf,
	3594.0	8.8 Kl	3614.8	9.3 M,
	3599.8	8.7 Wf,	3618.8	9.7 Lv,
	3604.8	8.6 Wf,	3623.6	9.5 M,
	3607.2	9.2 Ch,	3626.8	10.5 Br,
	3607.4	9.0 Gi,	3637.7	11.7 Wf,
	3610.7	9.0 Pt,	3640.7	12.0 Pt.

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
210124 V CAPRICORNI—						
	3563.3	9.8	Bl.	3605 6	10.4	Gi,
	3579.0	9.8	Bl.	3620.5	11.3	Gi,
	3596.2	10.0	Bl.			
210129 TW CYGNI—						
	3590.8	14.2	Pa,	3615.8	13.8	Wf,
	3604.8	14.0	Wf,	3618.8	13.8	Pa,
	3608.8	13.8	Pa,	3637.7	13.8	Wf.
210382 X CEPHEI—						
	3599.8	12.3	Wf,	3619.8	13.0	Wf,
	3604.8	12.5	Wf,	3637.7	13.5	Wf,
	3611.9	13.0	Wf,	3642.7	13.5	Wf.
	3615.8	12.9	Wf.			
210504 RS AQUARII—						
	3622.5	13.3	L,	3640.7	12.8	Pt,
	3633.8	13.0	Br.			
210516 Z CAPRICORNI—						
	3613.7	11.0	Pt.	3640.7	9.8	Pt,
210812 R EQUULEI—						
	3606.8	11.9	Wf,	3634.7	9.6	Br,
	3613.7	11.2	Pt,	3637.7	9.4	Wf,
	3615 8	11.0	Wf,	3640.7	9.0	Pt,
	3617.8	10.8	M.			
210868 T CEPHEI—						
	3561.3	6.1	Ch,	3618.6	6.5	Kl,
	3573.4	5.8	L,	3618.7	6.5	Sg,
	3581.5	5.7	L,	3619.6	7.3	O,
	3592.8	6.0	Sg,	3620.7	6.4	Kl,
	3593.4	5.8	L,	3622.3	6.3	Ch,
	3600.6	6.3	Ca,	3622.5	6.5	L,
	3606.7	6.4	Kl,	3622.5	7.0	An,
	3606.8	6.0	Sg,	3623.6	6.9	M,
	3608.7	6.0	M,	3626.7	6.3	Kl,
	3609.6	7.1	O,	3628.6	6.4	Kl,
	3609.7	6.5	Kl,	3631.7	6.3	Kl,
	3611.6	6.3	Ca,	3632.6	6.9	Ca,
	3611.6	6.3	L,	3638.7	6.5	Pt,
	3612.2	6.2	Ch,	3640.7	7.5	Sg,
	3613.7	6.1	Pt,	3651.6	7.1	Ca,
	3613.7	6.4	Kl.			
210903 RR AQUARII—						
	3613.7	12.9	Pt,	3640.7	10.5	Pt,
	3634.7	11.0	Pt.			
211614 X PEGASI—						
	3593.5	9.6	Gi,	3615.8	11.1	Wf,
	3599.8	10.1	Wf,	3617.6	11.6	Pt,
	3606.8	10.2	Wf,	3637.7	13.2	Wf,
	3611.9	10.9	Wf,	3645.6	13.4	Pt.
211615 T CAPRICORNI—						
	3563.3	12.0	Bl,	3617.2	9.0	Ch,
	3579.0	11.1	Bl,	3640.7	9.0	Pt.
	3596.2	9.7	Bl.			
212030 S MICROSCOPII—						
	3563.3	9.5	Bl,	3596.2	10.1	Bl.
	3579.0	9.8	Bl.			

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213244 W CYGNI—						
	3577.1	6.1	Kd,	3605.0	6.1-	Kd,
	3577.6	5.9	L,	3609.5	5.7	L,
	3582 4	6.9	An,	3610.0	6.2	Kd,
	3585.1	6.0	Kd,	3614.4	6.3	An,
	3591.1	6.1	Kd,	3619.0	6.2	Kd,
	3594.0	6.0	Kd.	3622.0	6.2	Kd,
	3597.1	6.0	Kd,	3630.6	5.5	L.
	3603.0	6.1	Kd,			
213678 S CEPHEI—						
	3604 8	9.8	Wf,	3623.6	10.8	M,
	3611.9	9.9	Wf,	3629.8	9.5	Br,
	3613.7	9.5	Pt.	3637.8	9.8	Wf,
	3615.8	9.8	Wf,	3638.7	8.9	Pt.
	3622.7	9.9	Lv,			
213753 RU CYGNI—						
	3561.3	9.0	Ch,	3614.2	8.8	Ch,
	3608 7	8.8	M,	3623.6	8.8	M,
	3613.7	8.5	Pt,	3638.7	8.5	Pt.
213843 SS CYGNI—						
	3518.0	11.4	Jb,	3616.8	11.8	Wf,
	3548.2	11.9	Nk,	3617.1	11.6	Ch,
	3548.3	11.7	Nk,	3617.6	[11.3	Ya,
	3549.2	10.8	Nk,	3617.6	11.9	Gd,
	3550.2	10.3	Nk,	3617.6	[11.0	Ly,
	3553.2	10.7	Nk,	3617.6	11.8	Pt,
	3553.3	10.0	Ch,	3617.7	12.0	Cd,
	3556.2	9.8	Nk,	3617.8	11.2	Lv,
	3558.2	9.0	Nk,	3618.4	11.6	Gi,
	3561.3	8.2	Ch,	3618.4	11.5	L,
	3562.3	8.2	Ch,	3618.6	11.7	Cd,
	3565.2	8.3	Nk,	3618.7	11.8	Fe,
	3571.3	9.2	Ch,	3618.8	11.8	Pt,
	3572.3	9.7	Ch,	3618.8	11.6	M,
	3573.4	10.0	L,	3619.0	[10.9	Jk,
	3575.3	10.1	Ch,	3619.2	11.7	Ch,
	3576.2	11.4	Nk,	3619.5	11.5	L,
	3577.0	[9.6	Jk	3619.6	11.8	Pt,
	3577.1	11.6	Nk,	3619.7	12.0	Je,
	3577.1	11.2	Kd,	3619.7	11.6	Ca,
	3577.6	11.4	L,	3619.8	11.7	Wf,
	3577.8	11.2	To,	3620.3	11.8	Ch,
	3579.4	11.2	Gi,	3620.4	11.6	Gi,
	3580.8	11.2	Jb	3620.6	11.8	Pt,
	3581.2	11.0	Nk,	3620.6	11.5	Ly,
	3581.5	10.7	L,	3620.7	11.7	Kl,
	3581.7	11.7	Wf,	3620.7	11.7	Br,
	3582.4	10.5	L,	3620.8	11 9	Wf,
	3582.4	11.2	Gi	3621.7	11.8	Br,
	3582.8	11.3	To,	3621.7	11.7	Pt,
	3584.4	11.2	Gi,	3621.7	11.6	Wf,
	3584.5	10.9	L,	3622.3	11.8	Ch,
	3585.8	11.6	Wf,	3622.5	11.4	L,
	3587.8	11.5	To,	3622.5	11.8	An,
	3590.5	11.8	Ro,	3622.7	11.5	Lv,
	3590.6	[10.9	O,	3622.7	11.8	Br,
	3591.7	11.8	Pt,	3622.8	11.9	Pt,
	3591.8	11.0	Sg,	3623.8	11.5	M,
	3593.1	11.2	Nk,	3623.8	11.6	Wf,

VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213843 SS CYGNI—Continued.						
	3593.4	11.9	L.	3624.4	11.5	L.
	3593.4	11.8	Gi.	3624.7	11.9	Br.
	3593.7	11.8	Pt.	3625.6	12.0	Kl.
	3594.0	12.0	Kd.	3625.6	11.8	L.
	3594.8	11.7	Br.	3626.6	11.8	Kl.
	3595.8	11.8	Pt.	3626.7	11.9	Br.
	3596.6	11.8	Pt.	3626.8	11.8	Pt.
	3596.7	11.7	Wf.	3626.8	11.8	Wf.
	3597.7	11.8	Pt.	3627.6	11.6	Ca.
	3598.6	11.8	Pt.	3627.7	11.8	Br.
	3598.7	11.2	Wf.	3627.8	11.8	Wf.
	3599.0	[10.0	Mk.	3528.7	11.9	Br.
	3599.7	9.1	Pt.	3628 8	11.8	Wf.
	3599.8	9.0	Wf.	3629.7	11.7	Pt.
	3600.5	8.7	Ro.	3629 7	11.9	Br.
	3600.6	8.6.	Ca.	3629.9	11.6	Br.
	3600.7	8.8	Wf.	3630.6	11.8	L.
	3600.7	8.8	Pt.	3630.7	11.7	Br.
	3601.4	8.6	Gi.	3631.6	9.8	Ca.
	3601.5	8.4	Ro.	3632.4	8.6	L.
	3601.6	8.3	O.	3632.6	8.9	Ca.
	3601.6	8.6	Ca.	3632.6	9.0	Pt.
	3601.7	8.8	Pt.	3632.7	8.6	Je.
	3601.8	8.9	Wf.	3633.6	8.2	Ly.
	3601.8	9.0	Br.	3633.6	8.4	Ca.
	3602.4	8.5	L.	3633.7	8.6	Sg.
	3602.6	8.9	Ca.	3633.7	8.9	Br.
	3602.8	8.9	Wf.	3633.8	8.5	Wf.
	3603.5	8.8	Ro.	3633.8	8.9	Pt.
	3603.8	9.5	Sg.	3634.7	8.7	Br.
	3604.5	**9.3**	**Ro.**	**3634**.8	8.8	Wf.
	3604.7	9.8	Pt.	3635.6	8.4	Ly.
	3604.8	9.6	Wf.	3635.6	9.0	Ca.
	3605.4	9.5	L.	3635.7	8.9	Fe.
	3605.4	9.8	Gi.	3635.7	9.4	Pt.
	3605.5	10.1	Ro.	3635.7	8.6	Br.
	3605.7	9.7	Kl.	3635.8	8.9	Wf.
	3605.7	10.1	Pt.	3636.6	9.1	Ca.
	3605.8	10.3	Wf.	3636.7	8.5	Ly.
	3606.2	9.9	Ch.	3637.6	9.7	Ca.
	3606.5	10.6	Ro.	3637.6	9.3	Ly.
	3606.6	10.3	Pt.	3637.6	9.9	Pt.
	3606.7	9.7	Kl.	3637.6	9.6	O.
	3606.8	**10.3**	**Wf.**	**3637.7**	9.4	Wf.
	3607.5	10.5	Gi.	3638.6	10.2	Pt.
	3607.6	10.8	Ca.	3638.6	10.0	Ly.
	3607.6	10.3	Pt.	3638 6	10.2	Fe.
	3608.2	10.4	Ch.	3638.7	10.2	Je.
	3608.5	10.6	Gi.	3638.7	10.0	Br.
	3608.6	10.2	M.	3638.8	9.8	Wf.
	3608.7	10.6	Pt.	3639 6	10.5	O.
	3609.5	10.6	L.	3639.7	10.2	Sg.
	3609.6	11.0	Kl.	3639.8	10.9	Wf.
	3609.6	10.9	O.	3640.6	10.5	Ly.
	3609.6	10.9	Pt.	3640.6	11.1	Ca.
	3609.7	11.1	Lv.	3640.7	10.8	Pt.
	3609.7	11.0	Br.	3640.7	11.1	Wf.
	3609.8	11.0	Wf.	3640.8	11.2	M.
	3610.4	10.7	L.	36.41.6	11.1	Fe.
	3610.4	11.3	Sg.	3641.6	11.0	Pt.
	3610.7	11.0	Sg.	3641.7	11.0	Br.
	3610.7	11.4	Pt.	3642.5	11.6	Ro.
	3610.8	10.8	M.	3642.6	11.5	Pt.
	3611.4	11.4	Gi.	3642.7	11.5	Br.
	3611.6	11.3	L.	3642.7	11.6	Wf.
	3611.6	11.6	Ca.	3643.5	11.4	Ro.
	3611.8	11.6	Wf.	3643.6	11.9	Fe.
	36.12.4	11.6	Gi.	3643 7	11.8	Br.
	3612.5	11.6	Ro.	3644.7	11.7	Br.
	36.12.6	11.7	Ca.	3644.7	11.6	Pt.
	3612.7	11.6	Wf.	3645.5	11.4	Ro.
	3612.7	11.8	Br.	3645.6	11.8	Pt.
	3612.8	11.3	To.	3646.5	11.4	Ro.
	3613.5	11.5	L.	3646.6	11.5	Pt.
	3613.7	11.7	Kl.	3647.6	11.5	Ly.
	3613 7	12.0	Pt.	3647.6	11.6	Cd.
	3614.2	11.7	Ch.	3647.6	11.6	Ca.
	3614.6	11.8	Pt.	3648.7	11.7	Cd.
	3614 6	11.0	Ly.	3649.6	11.9	Cd.
	3614.7	11.5	Sg.	3649.7	11.6	Pt.
	3614.9	11.5	Wf.	3650 6	11.5	Ca.
	3615.4	11.5	L.	3650.7	11.8	Pt.
	3615.4	11.6	Gi.	3651.6	11.5	Ca.
	3615.7	11.8	Br.	3651 7	11.8	Pt.
	3615.8	11.6	Wf.	3657.6	9.5	Pn.
	3616.7	11.8	Kl.			
213937 RV CYGNI—						
	3608.7	8.2	M.	3637.5	7.9	Cy.
	3613.7	6.6	Pt.	3638.7	6.6	Pt.
	3623 6	7.6	M.			
214024 RR PEGASI—						
	3606 8	11.4	Wf.	3637.8	10.1	Wf.
	3613.7	11.0	Pt.	3638.7	10.0	Pt.
	3615.8	10.4	Wf.	3640.8	10.5	M.
	3618.8	10.3	Pa.	3650 8	10.2	M.
	3622.9	11.5	Br.			
215605 Y PEGASI—						
	3606.8	11.9	Wf.	3618.8	10.1	Lv.
	3613.7	10.9	Pt.	3637.8	8.9	Wf.
	3615.8	10.2	Wf.	3638.7	9.5	Pt.
215717 U AQUARII—						
	3613 7	11.5	Pt.	3638.7	12.1	Pt.
215934 RT PEGASI—						
	3592.8	9.3	Sg.	3617.8	9.4	Lv.
	3606.8	9.5	Sg.	3638.7	9.9	Pt.
	3613.7	9.5	Pt.	3639.7	10.4	Sg.
	3615.2	9.3	Ch.	3647.8	10.5	M.
220133a RY PEGASI—						
	3613.7	11.8	Pt.	3638.7	11.8	Pt.
220133b RZ PEGASI—						
	3613.7	12.2	Pt.	3638.7	12.1	Pt.
	3617.8	12.4	M.	3645.8	9.8	M.

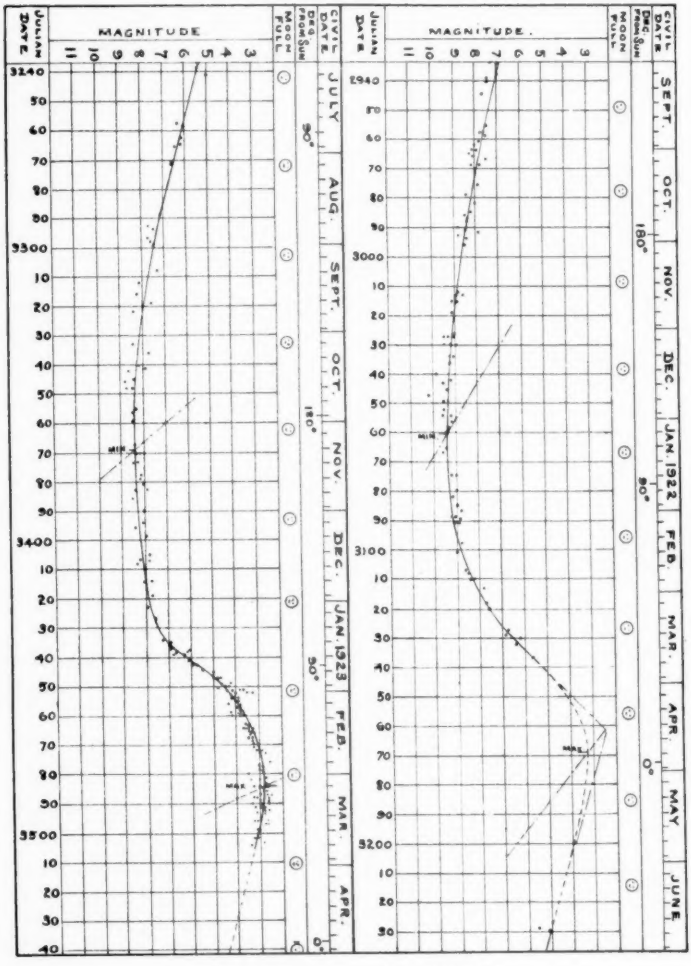
VARIABLE STAR OBSERVATIONS, June 20 to August 20, 1923—Continued.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.
220412 T PEGASI—				
	3584.6	9.6Gi,	3617.8	10.8 M,
	3605.6	10.4 L,	3618.6	10.8 L,
	3611.6	10.7 Gi,	3635.7	12.0 Br,
	3614.2	10.7 Ch,	3647.8	12.0 M.
220613 Y PEGASI—				
	3584.6	10.8 Gi,	3617.8	11.5 M,
	3611.6	11.1 Gi,	3622.8	12.0 Lv,
	3613.7	11.6 Pt,	3635.7	12.3 Br.
220714 RS PEGASI—				
	3584.6	12.9 Gi,	3613.7	13.0 Pt.
	3611.6	12.9 Gi,	3622.7	13.1 Lv.
221321 X AQUARII—				
	3617.8	8.3 M.		
221722 RT AQUARII—				
	3617.8	9.8 M.		
222129 RV PEGASI—				
	3635.8	10.8 Br,	3643.8	10.0 Br.
222439 S LACERTAE—				
	3582.5	12.3 Gi,	3618.6	9.7 L,
	3601.5	10.1 Gi,	3618.8	9.7 M,
	3605.6	10.0 L,	3638.7	8.5 Pt,
	3613.7	9.9 Pt,	3641.7	8.5 Br,
	3615.2	9.9 Ch.		
222867 R INDI—				
	3563.3	13.3 Bl,	3596.2	11.7 Bl.
	3579.0	11.9 Bl.		
223841 R LACERTAE—				
	3582.5	10.6 Gi,	3618.4	12.8 Gi,
	3601.5	12.0 Gi,	3618.6	13.0 L,
	3605.5	12.3 L	3618.8	12.5 M.
	3613.7	12.6 Pt,		
225120 S AQUARII—				
	3618.8	8.4 M.		
225914 RW PEGASI—				
	3610.8	9.7 M,	3623.6	10.3 M,
	3613.7	9.6 Pt,	3638.7	11.5 Pt,
	3622.9	11.3 Br,	3639.7	11.3 Sg,
230110 R PEGASI—				
	3610.8	12.0 M,	3622.9	11.3 Br,
	3612.7	10.8 Ca,	3640.7	12.2 Pt,
	3613.7	11.2 Pt,	3640.8	12.4 M,
	3619.7	11.9 Je,		
230759 V CASSIOPEIAE—				
	3584.5	8.2 Gi,	3609.7	7.8 Sg,
	3592.8	9.0 Sg,	3610.8	10.0 M,
	3601.5	9.1 Gi,	3613.7	10.0 Pt,
	3601.9	9.2 Br,	3618.5	9.8 Gi,
	3609.6	10.0 O,	3640.7	11.4 Pt.
231425 W PEGASI—				
	3605.6	13.0 L,	3622.7	12.3 Lv,
	3618.6	12.4 L,	3641.8	11.5 Br,
231508 S PEGASI—				
	3613.7	9.5 Pt,	3638.7	10.9 Pt.
	3615.3	10.0 Ch.		
232848 Z ANDROMEDAE—				
	3613.8	9.2 Pt,	3614.8	9.3 M,
	3614.3	9.4 Ch,	3638.7	9.3 Pt.
233335 ST ANDROMEDAE—				
	3606.8	10.9 Wf,	3637.8	10.7 Wf,
	3610.8	11.0 M,	3638.7	10.9 Pt,
	3613.8	10.9 Pt,	3639.7	10.6 Sg,
	3615.9	10.8 Wf,	3640.8	10.6 M.
	3622.9	11.0 Br,		
233815 R AQUARII—				
	3611.7	9.3 Ca,	3640.6	9.4 Ca,
	3613.8	9.4 Pt,	3640.7	9.2 Pt.
233956 Z CASSIOPEIAE—				
	3601.9	12.5 Br,	3614.9	12.7 Wf.
	3606.8	12.4 Wf,	3637.8	12.9 Wf.
235053 RR CASSIOPEIAE—				
	3613.6	10.5 Gi.		
235209 V CETI—				
	3640.7	12.5 Pt.		
235350 R CASSIOPEIAE—				
	3610.8	12.0 M,	3629.7	11.6 Br.
235525 Z PEGASI—				
	3613.8	12.5 Pt,	3640.8	13.1 Pt.
	3622.9	13.1 Br,		
235715 W CETI—				
	3621.6	13.3 Gi.		
235855 Y CASSIOPEIAE—				
	3584.5	10.7 Gi,	3624.8	11.8 Br.
	3613.6	11.9 Gi.		
235939 SV ANDROMEDAE—				
	3613.8	9.0 Pt,	3640.8	10.6 Pt.
	3622.9	9.6 Br,		

The following observers have contributed to this report: Messrs. Ancarani "An", Baldwin "Bl", Brocchi "Br", Carr "Ca", Chandler "Cd", Chandra "Ch", Christie "Ct", Cilly "Cy", Fant "Ft", Ferry "Fe", Ginori "Gi", Godfrey "Gd", Jacobsen "Jb", Miss Jenkins "Jk", Jewell "Je", Kanda "Kd", Kleis "Kl", Lacchini "L", Leavenworth "Lv", Mrs. Lytle "Ly", McAteer "M", Nakamura "Nk", Olcott "O", Parkhurst "Pa", Peltier "Pt", de Perrott "Pe", Prentice "Pn", Rhorer "Ro", Skaggs "Sg",, Townley "To",, Waterfield "Wf", Yalden "Ya".

	Observations	Observers
June 20-July 20	1581	31
July 20-Aug. 20	1515	23
	3096	32

HOWARD O. EATON, Recording Secretary.



LIGHT CURVE OF *o* CETI *(0.21403)*

Derived from 280 observations by members of the A. A. V. S. O.
Plotted by W. E. Inglis, Bridgeport, Conn.

COMMUNICATIONS.

The Interior of a Star. — Recently there appeared in THE SCIENTIFIC MONTHLY an extract from a lecture on "The Interior of a Star," given before the Royal Institution of Great Britain, February 23, 1923, by A. S. Eddington, the distinguished astronomer of the University of Cambridge, as follows: "We have hitherto pictured the inside of a star as a hurly-burly of atoms and ether waves. We must now introduce a third population to join in the dance. There are vast numbers of free electrons—unattached units of negative electricity. More numerous than the atoms, the electrons dash about with a hundred-fold higher velocity, corresponding to their small mass, which is only 1/1850th of a hydrogen atom. These electrons have come out of the atoms, having broken loose at the high temperature here involved."

Apparently, Prof. Eddington announces this as a new theory. If he does, may I claim its prior announcement by an astronomer of my city, John Candee Dean?

IN POPULAR ASTRONOMY of November 1915, page 542, speaking of the dissociation of atoms into electrons by the transcendental temperature of the hottest stars, Dr. Dean wrote: "The heat of the sun is probably sufficient to disassociate all chemical combinations, consequently interior solar matter is in its monatomic, or elementary condition, and much of it may be in the electronic state. Perhaps there is a critical, or maximum temperature for all matter, where the violence of the motion of clashing atoms causes them to break up into electrons. In stars of the highest temperature, like Gamma Argus, or Zeta Puppis, the critical state has probably been reached and the greater part of their matter is in the form of electrons. When matter is in its hottest state, it is at its lowest point in the scale of evolution, and progress depends on a fall of temperature by radiation."

If Dr. Dean can claim eight years priority for this theory, I am sure it will be of sufficient interest for you to publish this statement.

FRANK S. C. WEEKS.

1453 N. Alabama St., Indianapolis, Ind., September 20.

Gyroscopic Motion. — The socalled "classical" theory of gyroscopic motion is vitiated by an erroneous assumption indulged in by mathematicians respecting the "deflective force", which, combined with the force of gravity, causes the festooning of the spinning wheel where no horizontal impulse is imparted when it is released.

This assumption is that the "deflective force" is not impaired by the generation of the *circular* motion which its application produces.

It is assumed that where only the *direction* of motion is changed—not the *velocity*—the force which causes such change does no "work" and hence that no force is expended in the generation of such effect. The theory is that the "deflective force" merely *maintains existing motion* and that as nothing is *generated* nothing is *expended*. The theory is erroneous. We are not dealing with a body considered as a *mathematical point*, but with a real body. In such case the "de-

flective force" does not maintain the existing motion. *It destroys existing motion and generates new motion.* Work is done on the body the same as when force is applied to the generation of motion from rest or to the increase or decrease of existing motion. The motion which is destroyed is transformed into heat and its place is taken by newly generated motion. This work exhausts the "deflective force". It is transformed into its generated effects.

It follows necessarily that the "deflective force" stored in the spinning wheel will be spent regardless of friction and windage. And as it is spent the wheel descends. The cusps of the festoons will not lie in a horizontal plane as the mathematical theory asserts, but each cusp will be lower than the preceding one.

A gyroscope is not, as it has been called, a "mathematical device." It is a *body* and its behavior does not conform to the requirements of a theory based on a mathematical assumption in disharmony with the reality.

Proceeding from this erroneous assumption the mathematical astronomers have concluded that the average inclination of the earth's axis will always remain constant, whereas the truth is that the axis is rising (spirally) and ultimately will be perpendicular to the earth's orbital plane.

L. A. REDMAN.

San Francisco, September 5, 1923.

Sunspots Observed at Alta, Iowa.—Sunspots observed so far during the present year have been very small and short lived and the preponderance of days without spots would indicate that the minimum must be close at hand, if not already passed.

A small group of spots was on the disc during the latter part of June which on the 29th increased to a considerable size, later diminishing before disappearance at the west limb. On July 30 a small spot in bright faculae was noted in south latitude 27° but soon faded out and the disc was spotless during August, but on September 2 this disturbed region was again in evidence and a group of numerous small spots near the central meridian in latitude south 30 degrees which was spectroscopically active and continued visible until it passed the west limb on September 9.

It would appear that the new cycle of sunspot activity has commenced by the appearance of these high latitude groups. DAVID E. HADDEN.

September 17, 1923

ANOTHER DAY.

The shadows darken,—not a breath of breeze
Awakes a quiver in the poplar trees;
The sunset fades,—a dank, pervading chill
Of coming nightfall creeps from vale to hill.

A new moon sets, the stars mount one by one,
And church clocks toll that midnight's day is done;
Within the modern tome of our own age,
Time's sleepless hand entombs another page.

CHARLES NEVERS HOLMES.

Newton, Mass., 41 Arlington St.

GENERAL NOTES.

The Reverend Stephen Dows Thaw, formerly assistant at the Allegheny Observatory, died on August 22 at the home of his wife's parents in Zurich, Switzerland, after a long illness, in his thirty-seventh year.

Dr. S. S. Hough.—Word has just been received (August 8) of the death of Dr. S. S. Hough on July 8 from cancer of the stomach. Dr. Hough was His Majesty's Astronomer at the Cape of Good Hope, having succeeded to this important post on the retirement of Sir David Gill about fifteen years ago.

Mr. Harold Spencer Jones, chief assistant at the Royal Observatory, Greenwich, has been appointed Director of the Cape of Good Hope Observatory to fill the vacancy caused by the death of the former director, Dr. Hough.

Mr. Issei Yamamoto, of the Kyoto University Observatory, spent the past summer at the Mt. Wilson Observatory in solar study. He was a member of the Yerkes Observatory Eclipse Expedition on September 10. He will spend the winter months at the Harvard College Observatory.

The Total Solar Eclipse of September 10. — It is too early, as this number of POPULAR ASTRONOMY goes to press, for many of the reports of observations to have reached us. Next month we expect full reports from some of the parties who were successful in observing the eclipse.

Unfortunately bad weather prevented observations at three of the stations occupied by the best equipped parties, viz., the Yerkes Observatory expedition on Santa Catalina Island, the Mount Wilson Observatory expedition at Point Loma, near San Diego, California, and the Lick Observatory expedition near Ensenada, Mexico.

The Sproul Observatory expedition, located at Yerbaniz, near Durango, Mexico, the Steward Observatory expedition located on the eastern coast of the gulf of California, the Mexican Government expeditions at Yerbaniz and Berrendo, Mexico, and the German expedition at Pasage, Mexico, were more fortunate, all obtaining good photographs of the solar corona and carrying out their programs in other respects.

The photograph from which our Frontispiece was prepared this month was obtained by Mr. James Worthington at Lompoc, near Santa Barbara, California, only a few miles inside the path of totality. It was taken through very thin clouds, but shows the details of the outer corona fairly well. The longer streamers lie approximately parallel to the sun's equator, as seems to be usual at the times of sunspot minima.

The Pomona College expedition, headed by Professor F. P. Brackett, located at "The Isthmus," on Catalina Island, about 15 miles from Avalon, had broken thin clouds during the eclipse and secured some imperfect photographs of the corona.

The Goodsell Observatory party, consisting of Professor and Mrs. H. C. Wilson, Professor E. A. Fath, Miss Anna D. Lewis, Mrs. Elizabeth M. Ashton, and Mr. J. H. Darling of Duluth, Minn., was located at Camp Wrigley, at an elevation of 1300 feet, on "Summit" near Avalon, Catalina Island, together with the Yerkes Observatory expedition, that from the Drake University Observatory, Des Moines, Ia., and that from the Washburn Observatory, Madison, Wis. Other observatories represented there were the Dearborn Observatory, Evanston, Ill., Mt. Holyoke Observatory, South Hadley, Mass., Harvard College Observatory, Cambridge, Mass., Whitin Observatory, Wellesley, Mass., Smith College Observatory, Northampton, Mass., Denison University, Granville, O., University of Toronto, Canada, Dominion Astronomical Observatory, Victoria, B. C., Kyoto University, Kyoto, Japan, Perkins Observatory, Delaware, O., Ebro Observatory, Tortosa, Spain.

Of course there was great disappointment at Camp Wrigley on the day of the eclipse when the fog, which often covered the mountain in the morning, did not dissipate as usual toward noon but lifted only to reveal dense clouds above. The previous six days had been perfectly clear through the middle of the day. The various pieces of apparatus were all adjusted and the parties had rehearsed their programs several times each day. Even though there was no hope as the time of totality approached that the clouds would break away, still the programs were run through according to schedule, the times of beginning and end of totality being called off by predicted clock time instead of observation. The sudden increase and decrease of darkness as shown through the clouds coincided very closely with the predicted times of second and third contacts.

Although the results were disappointing, we had the satisfaction of a large group of observers working intimately together, with intense concentration on the problems in hand, and a common bond of sympathy when failure met the best efforts we could make.

The following is an almost complete list of the members of the eclipse expeditions at Camp Wrigley:

Professor Edwin B. Frost, director of Yerkes Observatory, University of Chicago.
Professor John A. Parkhurst, Yerkes Observatory.
Dr. Oliver J. Lee, Yerkes Observatory.
Captain B. W. Harris, Chicago, Ill.
Professor Philip Fox, director Dearborn Observatory, Evanston, Ill.
Dr. H. B. Curtis, Northwestern University.
Mr. Lloyd R. Wylie, Dearborn Observatory, Evanston, Ill.
Dr. Albert O. Howe, Chicago, Ill.
Professor H. R. Kingston, University of Western Ontario, London, Ontario, Can.
Professor Joel Stebbins, director of Washburn Observatory, Madison, Wis.
Professor Jacob Kunz, University of Illinois.
Professor Herbert C. Wilson, director Goodsell Observatory, Northfield, Minn.
Professor E. A. Fath, Goodsell Observatory, Northfield, Minn.
Mr. C. T. Elvey, University of Kansas.
President D. W. Morehouse, Drake University, Des Moines, Iowa.
Mr. Charles Morehouse, Drake University.
Mr. Parmelee Daniels, Drake University.
Professor S. J. A. Wifvat, Drake University.
Mr. Oscar Romare, University of Wisconsin, Madison, Wis.
Mr. W. R. Jewell, Danville, Ill.
Professor Paul Biefeld, Denison University, Granville, Ohio.
Mr. Warren Gorrell, Chicago, Ill.
Prof. and Mrs. Issei Yamamoto, Kyoto University, Japan.

Dr. J. S. Plaskett, F. R. S., director Dominion Astronomical Observatory, Victoria, B. C.
Mr. Charles Ridel, Yerkes Observatory, Williams Bay, Wis.
Captain H. M. Foote, Yerkes Observatory, Williams Bay, Wis.
Prof. Ernest Bryant.
Dr. Frank D. Urie, Elgin, Ill.
Mr. J. W. Campbell.
Mr. Robert Greenleaf, Terra Haute, Indiana.
Professor C. C. Crump, director Perkins Observatory, Delaware, Ohio.
Professor Anne S. Young, director Williston Observatory, Mt. Holyoke College, South Hadley, Mass.
Dr. Alice M. Farnsworth, Mt. Holyoke College, South Hadley, Mass.
Miss Mary Ross Calvert, Yerkes Observatory, Williams Bay, Wis.
Miss Bertha Calvert, Nashville, Tenn.
Miss Elizabeth Young, Winona Lake, Indiana.
Miss Annie J. Cannon, Harvard College Observatory, Cambridge, Mass.
Miss Helen Barrett, Williams Bay, Wis.
Miss Harriet Bigelow, director of Smith College Observatory, Northampton, Mass.
Mrs. J. S. Plaskett, Victoria, B. C.
Mr. Harold G. Foote, Williams Bay, Wis.
Mrs. H. M. Foote, Williams Bay, Wis.
Mrs. H. R. Kingston, London, Ontario, Can.
Mrs. J. A. Parkhurst, Williams Bay, Wis.
Mrs. H. C. Wilson, Northfield, Minn.
Mrs. R. W. Ashton, Los Angeles, Cal.
Miss Anna D. Lewis, Lake Erie, College, Painesville, O.
Prof. J. C. Duncan, director Whitin Observatory, Wellesley, Mass.
Mrs. J. C. Duncan, Wellesley, Mass.
Father Luis Rodés, Ebro Observatory, Tortosa, Spain.
Mr. J. H. Darling, Duluth, Minn.

Reports have been received from several who observed the partial phases of the eclipse. These are given below.

OMAHA.—We had fine weather here yesterday for the eclipse. Clouds began to appear towards the end, but they did not prevent the observation of the last contact. I found the moon to be 11 seconds slow at the first contact and 15 seconds slow at the last. No correction was applied to the Ephemeris.

WILLIAM F. RIGGE.

Omaha, Neb., Sept. 11, 1923.

PHILADELPHIA.—First and last contact in the eclipse of Sept. 10 were observed with the 18-inch to occur respectively at $8^h\,42^m\,35^s$ and $10^h\,29^m\,20^s$ G.M.T.

S. G. BARTON.

Sept. 11, 1923.

CAMBRIDGE, MD.—I have just finished a three-inch telescope which I have been working on for several years and viewed the eclipse with it yesterday. The time of the first contact, as I observed it, was $3^h\,42^m\,18^s$, Eastern time, and the last contact was $5^h\,32^m\,45^s$. The latitude and longitude of my station are latitude 38° 41′ 11″, longitude 76° 04′ 46″.

The weather was ideal, the sky was perfectly clear all day and the seeing good.

My time was corrected by U. S. Naval Observatory time a few minutes before my observation, and corrected again between the first and last contact.

J. WATSON THOMPSON.

Sept. 11, 1923.

ALTA, IOWA.—The eclipse of the sun September 10 was visible here as a partial one, about 55 per cent of the disc being obscured. The sky was clear and the condition for observing it ideal. The approximate times of first and last contacts were taken from Prof. Rigge's charts in the May number of POPULAR ASTRONOMY and the observed times did not differ very much from them, which was very satisfactory considering the small scale of the charts.

The first contact was noted by the writer at $2^h\ 8^m\ 58^s$ and is hardly in error to exceed 4 seconds, the last contact was timed at $4^h\ 19^m\ 12^s$ by Prof. Lloyd Jensen who assisted in the observations. The full aperture of the 5½ inch refractor was used. A small group of spots in the northeast quadrant was just outside the obscured portion.

Temperature readings were taken every 15 minutes and a fall of 2 degrees observed during the 30 minutes near mid-eclipse.

Accurate time was obtained from the noon Western Union telegraph signals. Longitude $6^h\ 21^m$. Latitude 42° 40′.

DAVID E. HADDEN.

PINE HILL LABORATORY, NORTH SCITUATE, R. I.—We had very clear weather for the eclipse here on Sept. 10 and both Mr. Seagrave and myself observed the first and last contacts. First contact occurred at $3^h\ 44^m\ 2^s$ E.S.T. and the last contact at $5^h\ 25^m\ 26^s$ E.S.T. Two very small sun spots were seen close together on the lower portion of the sun's disk, the first that I have seen for months.

LEWIS J. BOSS.

The Shadow on the Clouds at Summit, near Avalon, Catalina Island. — I wish to thank you heartily for suggesting going up to Summit yesterday to view the effect of the shadow on the clouds, the only hope for any real observation. Perhaps you will be interested in my account of what I saw.

Watching toward the northwest for the blackening of the clouds with the total phase, I was at first surprised to see the blackening almost due west, to the left of a sharp little peak visible from Summit. The darkness spread very rapidly, almost too rapidly to follow, to the right beyond the north point, when the whole cloud belt seemed to rise abruptly, having a nearly horizontal upper line, very menacing it appeared to me. No wonder the ancients were frightened at such a phenomenon. Very quickly the dark cloud band reached the zenith when it was evident that totality was on, but the darkening was, I take it, less sudden than would have been the case on a clear day, on account of the bright clouds not only to the S.E. but all along the N.E. where the horizon continued bright throughout. At this moment I noticed what looked so like a group of islands to the north, perhaps ten miles away, that it was with actual difficulty that I convinced myself I was observing low clouds, or fog, below the level of my eyes. These I had not noticed before, and after the eclipse was over I could barely make them out, though so conspicuous during the total eclipse.

Almost before the blackness had spread over the S.E. the N.E. brightness began to spread rapidly to N., then N.W., then W. when the total phase was over. Light seemed to increase more rapidly than it had diminished. The southern horizon was the last to grow light, and the western upper clouds were black the longest of any. Our view to the west and southwest was not so advantageous as in other directions owing to the hills in that direction. It was sufficiently evident, however, that the longest totality was to the west of our

position. I had looked for the initial blackness at the NW., but it was west.

The black line of clouds rose with an almost horizontal line, as I said above, but the bright line after totality was not horizontal at all, rising soonest at the North, and decidedly later at the N.W. and last of all at the W. at about the instant of ending of totality at my position.

We had a few drops of rain just at the close of the totality time, lasting less than one minute I should estimate. I mention this as perhaps you were indoors, or perhaps indeed there was no rain so near at Camp Wrigley. Was this rain due to the sudden cooling of the upper air during totality? Don't trouble to answer this question. It was merely put as a tentative theory in the interrogative form.

From your timely suggestion I got a deal more of interest from the eclipse than would otherwise have been the case, and so I write to thank you for thus saving the day for me.

I saw no shadow-bands.

MORGAN BROOKS.

Written on Sante Fé train eastbound,
September 11, 1923.

Meeting of the American Astronomical Society. — In accordance with the announcement published in the June-July number of POPULAR ASTRONOMY, the thirtieth meeting of the American Astronomical Society was held on September 17-19, in Los Angeles and Pasadena and on Mount Wilson, and a large number of members were present. The sessions of the Society on Monday were held at the University of Southern California. In the afternoon a symposium on Eclipses and Relativity was open to all members of the American Association for the Advancement of Science. Addresses were given by Dr. W. W. Campbell, president of the University of California, on "Some conditions apparently existing in the Solar Corona;" by Dr. S. A. Mitchell, director of the McCormick Observatory, on "How the spectrum of the Sun's Atmosphere is studied at eclipses and the interpretation of the results through the aid of modern Physics;" by Dr. C. E. St. John, of the Mount Wilson Observatory, on "The constitution of the Sun's Atmosphere, the levels of the gases and the nature of their circulation;" and by Dr. R. J. Trumpler of the Lick Observatory, on "Relativity as represented by the Einstein-Eclipse problem."

After the symposium reports were given by the successful eclipse observers and a few photographs of the corona and the observing stations shown by lantern slides. In the evening an address was given by Dr. E. P. Lewis, president of the Pacific Division of the A. A. A. S., on "The Contributions of Astronomy to Civilization."

Tuesday's sessions were held in the Laboratory of the Mount Wilson Observatory and at the Norman Bridge Laboratory of Physics, California Institute of Technology.

On Wednesday, about 80 members of the Astronomical Society made the stage journey up Mount Wilson and after luncheon at the Monastery a session for papers was held in the dome of the 100-inch reflector. At this session an interesting paper by Dr. George E. Hale was read by Dr. Adams, on "The possibilities of instrumental development." A telegram was read from Dr. Hale, who had just landed in New York.

There was ample time left for the inspection of the wonderful instruments on

Mount Wilson and in the evening the 60-inch and the 100-inch reflecting telescopes were at the disposal of the guests for viewing certain objects. The sky was clear and many took advantage of the opportunity.

The Position of Jupiter's Red Spot.— An observation of Jupiter on April 30, 1923, furnished the position of the Red Spot Hollow, which at $14^h\ 23^m$, G. M. T., was in longitude 223.9 degrees. (Center).

On November 6, 1916, it was in longitude 132 degrees, and the motion in decreasing longitude was then 0.107 degrees per day. At that rate the position should be Longitude 218.7 degrees on November 6, 1923. Thus, it can be seen that the daily rate of motion has been a little ahead of normal, and the change in longitude about 15.1 degrees ahead of the predicted position on April 30.

The Red Spot seems again involved in the forward part of the dark region known as the Great South Tropical Disturbance, whose motion in decreasing longitude is swifter than the Red Spot's motion. When these objects approach, at first the Red Spot is retarded, then its motion forward is accelerated.

LATIMER J. WILSON.

An Old Celestial Sphere.— There is at Lisbon a glass celestial sphere of English make, which its owner wishes to sell. The glass globe is 84 centimetres (33 inches) in diameter and inside it is a terrestrial globe of 10 centimetres (4 in.) diameter. Horizon, meridian and stand are of bronze, graduated in degrees, a compass rose being traced on the horizon. The stars and the constellation figures, with their Latin names, are beautifully engraved on the glass, as well as equator, ecliptic, tropics and polar cricles.

Between Ursa Major and Auriga is written

J. COWLEY
LONDINI
SCULPSIT
1730

and above it, nearer to the pole, are four stars numbered according to magnitude, with the legend: Magnitudines stellarum.

The glass sphere revolves around the earth globe on a bronze spindle.

Anyone interested in it may address Mr. Silva Sanches, Chief 2d postal section, Lisbon Post Office, Lisbon, Portugal.

Star of Highest Density. — In the Astronomical Journal, No. 821, F. C. Jordan announces the discovery and gives the preliminary light curve of an eclipsing variable star of the eleventh magnitude that has a period of $0^d.2372$, or a little less than six hours. The alternate minima are of comparable depth, and an inspection of the curve indicates that the components are elliptical dwarf stars of high density. Past experience in computing the orbits of binaries of this kind justifies the assumption that the components of the new variable are approximately equal in size, and we may therefore compute with considerable certainty the upper and lower limits of the mean density, without further knowledge of the orbit.

Letting P and D denote the period and the total duration of an eclipse, it

can be shown that the mean value of the density for the system lies between $0.054/P^2\sin^3\theta$ and $0.43/P^2(1+3\sin^2\theta)^{3/2}$, where $\theta = \pi D/P$. For W Ursae Majoris, the eclipsing star more like Jordan's variable than any other for which an orbit has been computed, the value of P/D is 4.4 (darkened orbit). Using this value we find from the formulae above that the mean density lies between 3.4 and 2.2, in terms of the solar density.

The mean density of W Ursae Majoris is 1.84 (darkened orbit). Probably, therefore, the new variable has the highest stellar density at present known. Its period is the shortest among eclipsing stars, the two next in order being SW Lacertae, $0^d.321$, and W Ursae Majoris, $0^d.334$.

Harvard College Observatory Bulletin 789.
Cambridge, Massachusetts, June 27, 1923.

Not Quite the Same.—There is growing up a distinct Einstein tradition concerning the great mathematician's habit and personality. The following is the latest addition to the collection:

Einstein was walking bareheaded across Bavarian square in Berlin. One of his friends hailed him:

"Well, what do you think of Poincaré?"

"I think he is a very talented man."

"Yes, but what daring!"

"The daring of genius."

"But what a frenzied fury against his antagonist!"

"Oh, no, not at all. You don't know him."

"Well, but at least professor, you won't deny that he is determined enemy of Germany, and that his megalomania—"

"Oh," said Einstein, "you're talking about Raymond Poincaré, the premier. I was thinking of Henri Poincaré, the mathematician."—Argonaut.

Erratum. — Our attention has been called to an obvious error in connection with Plates XI, XII, XIII, XIV, XV, and XVI in the April, 1923, issue. The title for each of these plates should be "Drawings of Mars 1920." instead of "Drawings of Mars 1922."

END IS THERE NONE?

"End is there none to the universe of God?"
"End is there none to the universe of God, and there is no beginning."
JEAN PAUL FREDERICK RICHTER.

One night, as rapt I looked upon the stars
And longed to solve their mystery,
An angel laid his hand on mine and said,
"Come, come with me."
Out from Earth's grasp we passed and onward fled
Till, looking back, we saw
Our world in semblance but a star.
And soon before our eyes another world appeared

So like to Earth that we had thought
Ourselves returned;
For Mars with swift revolving moons came into view.
No pause we made but on we sped,
Past tiny worlds so small they seemed
But little islands of the sky.
And soon before us stood great Jupiter,
A bright and glittering mass
More brilliant than our moon;
And round about him whirled great moons
Like mimic worlds.
On, on we went
Till Saturn with his shining rings and divers moons
Greeted our sight.
So fast we fled, that soon were passed
Uranus and Neptune, outposts of our Sun,
And passed were lonely comets on eccentric ways.
Then to my guide I said,
"End is there none to the universe of God?"
For answer, on we rushed.
And moments changed to seeming hours
And hours to months and years
Before we reached another star
Like to our Sun—though greater far.
Swifter than light we sped.
Past twinkling stars with planets circling round,
Myriad on myriads—no count we kept;
Past Hercules, past Virgo,
Till bright Vega had become
A pale and distant star.
What we had seen as shining mass of light
A galaxy of mighty stars became
Like to our own.
Again, I said,
"End is there none to the universe of God?"
Then other galaxies of stars were passed
And our own universe appeared
As held between gigantic covex lens
Shining and whirling in far distant space.
Once more I asked,
"End is there none to the universe of God?"
"End is there none to the universe of God, and there is no beginning,"
Answered my guide.

Mary E. Perry.

324 North Euclid Avenue, Oak Park, Illinois.